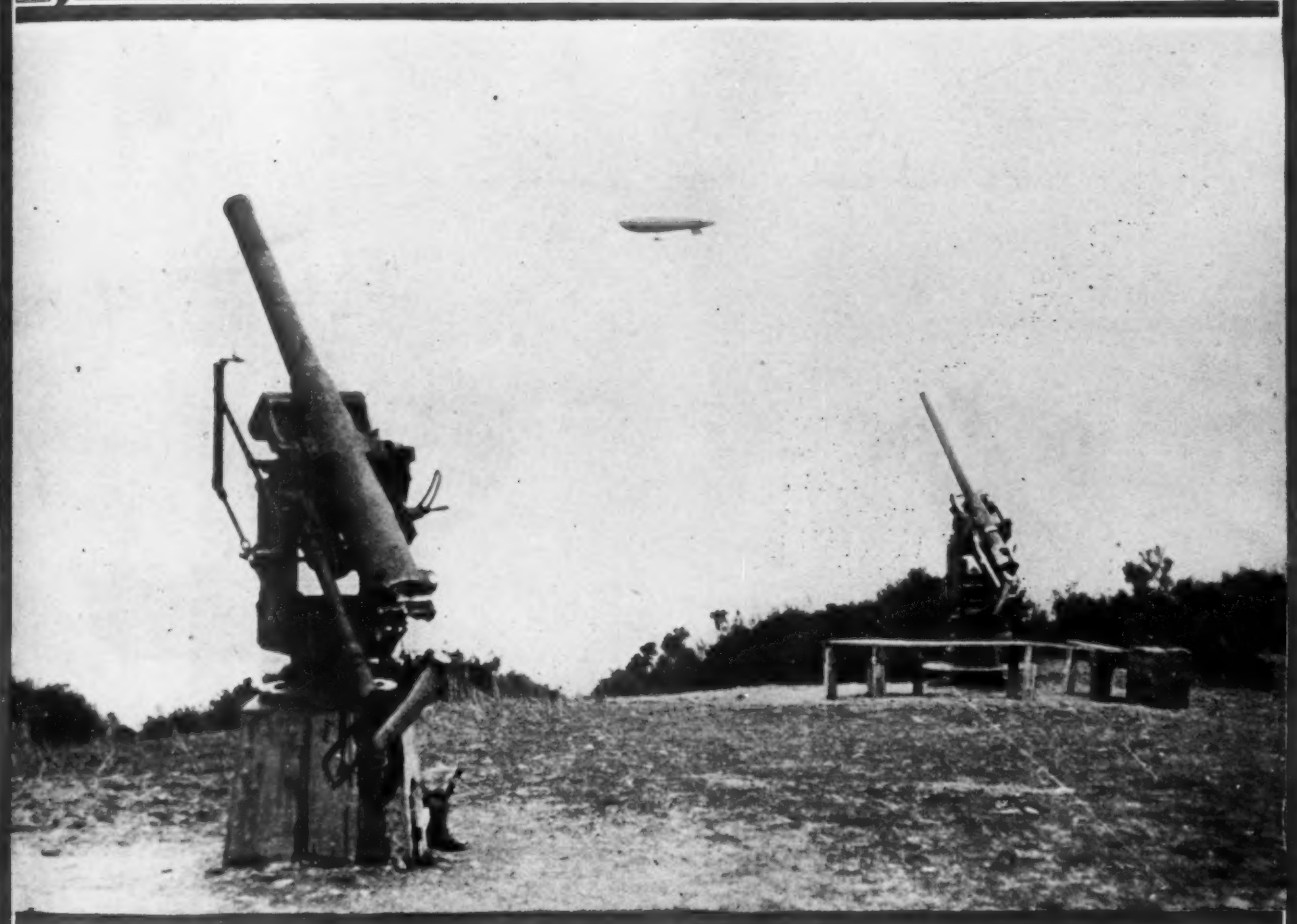
AVIATION AND AERONAUTICAL ENGINEERING



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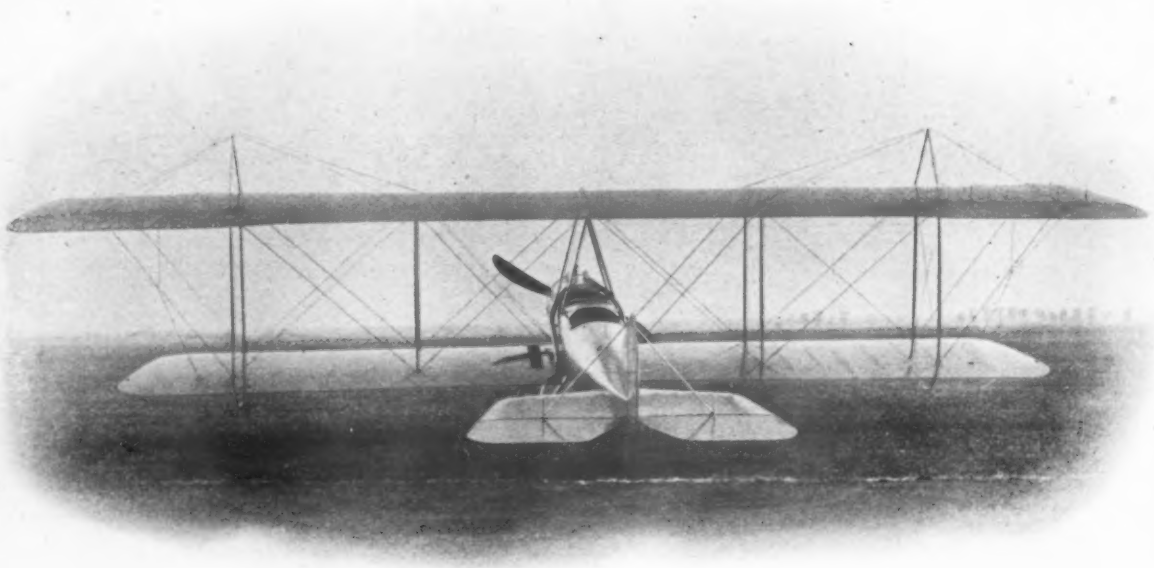

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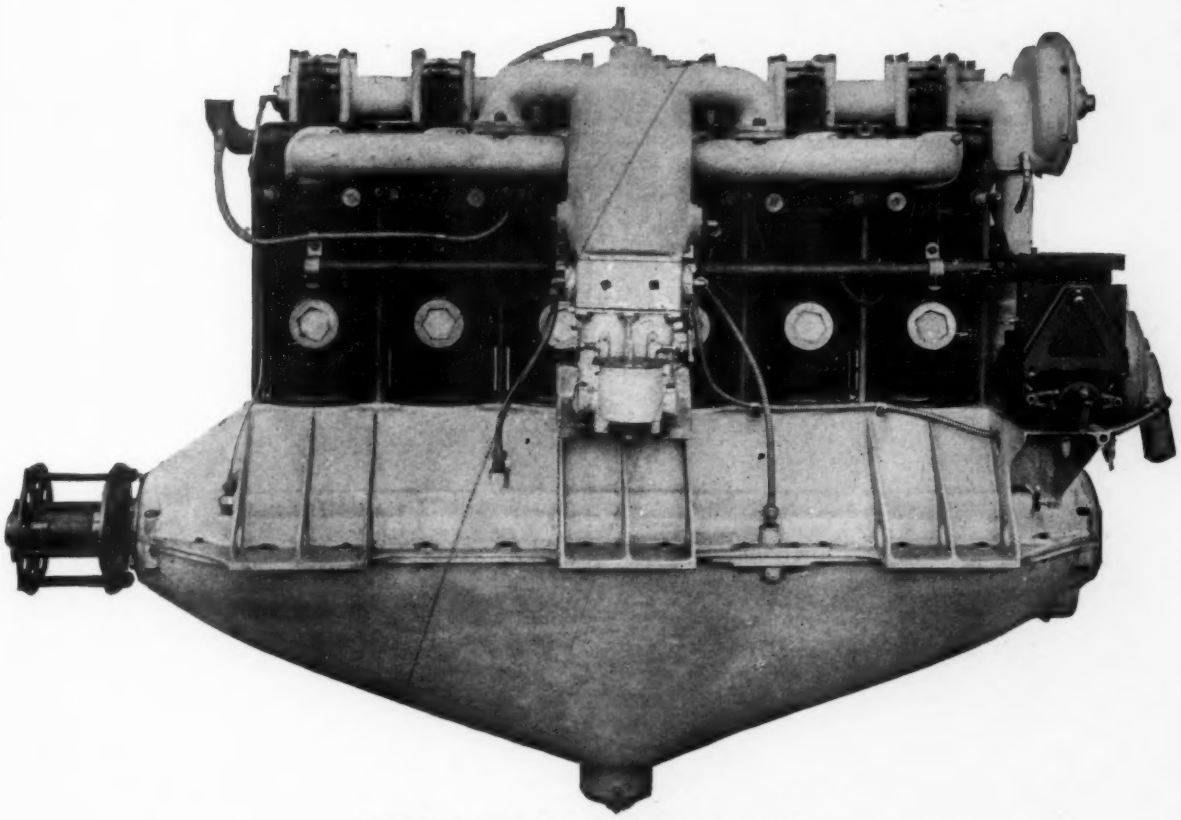

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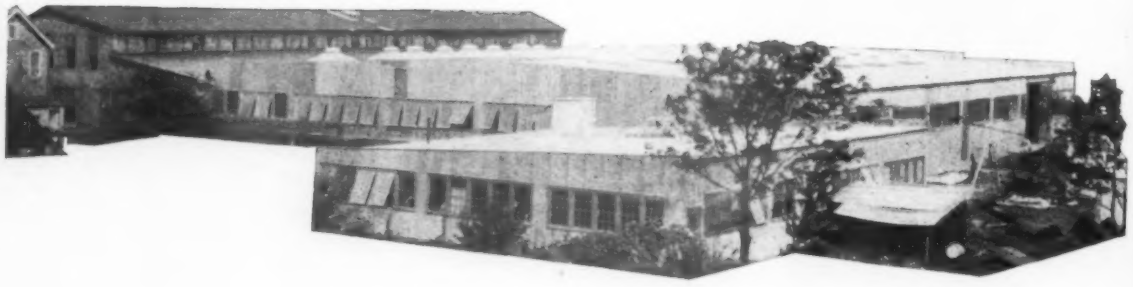

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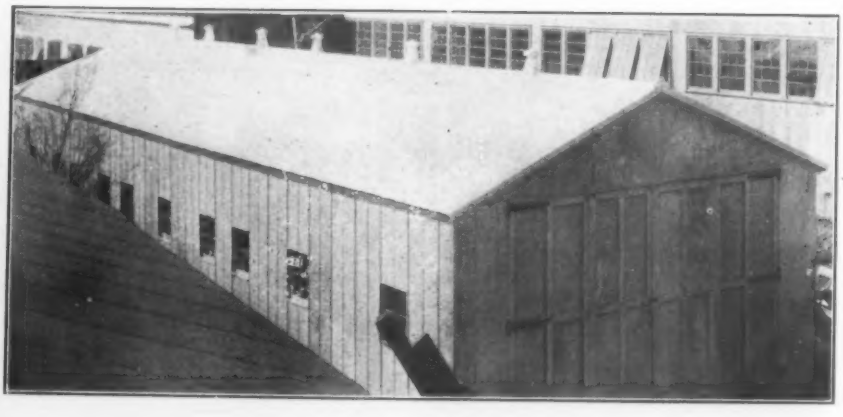

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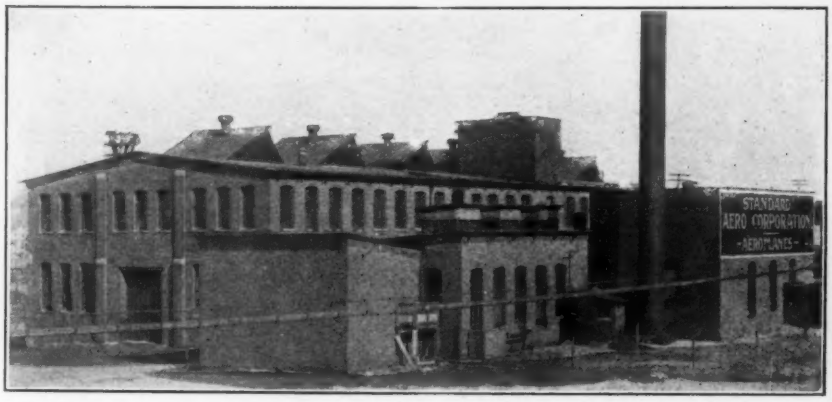

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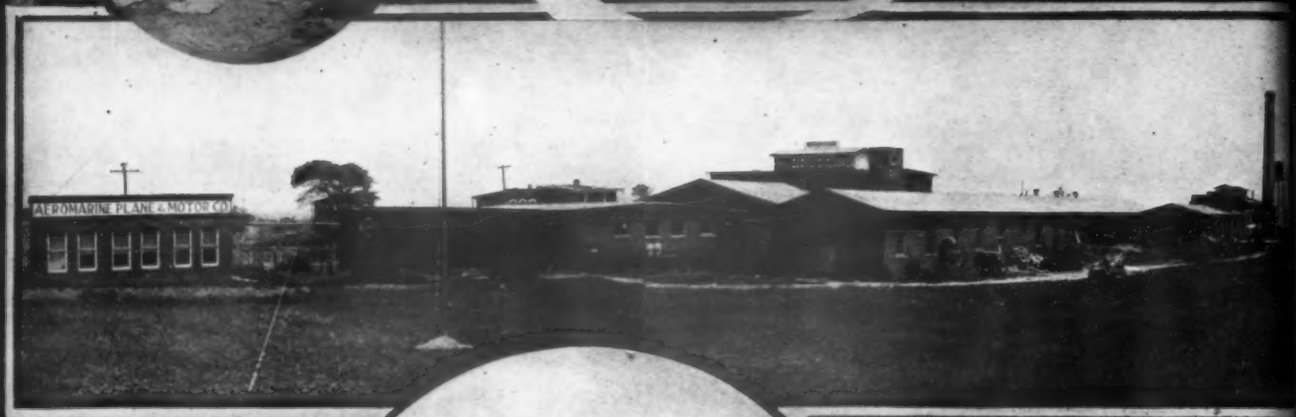

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JULY 1, 1917

AVIATION
AND
AERONAUTICAL ENGINEERING

VOL. II. NO. 11

Member of the Associated Business Papers

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AVIATION AND AERONAUTICAL ENGINEERING

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Massachusetts Institute of Technology

BUSINESS MANAGER
GEORGE NEWBOLD

Vol. II | July 1, 1917 | No. 11

THE Senate Committee on Military Affairs, which has been holding hearings on the bill to create a separate department of Aeronautics with a new cabinet officer at its head, has received the opinions of both the Secretary of War and the Secretary of the Navy. It is apparent from the statement of the Committee that the plan will not be pressed at this time but will await the hearings on the appropriation bills now being prepared by both the Army and the Navy.

The Army bill aside from calling for an expenditure of about $640,000,000 for an air service for the Army will probably contain an organization plan for the expanded service. The expenditure of this appropriation will call for a service of several hundred thousand officers and enlisted men. It is to be hoped that the bill will give the American Air Service a sufficient number of officers of high rank. A service that will be almost three times the size of the whole U. S. Army on a peace basis will need many officers of superior executive ability.

The Navy has not as yet given any indication as to its plans or wishes. There has seemed to be very little attention given to the great problem of naval aeronautics by the Government. Pensacola as it is to-day is not worthy of its position as the chief aviation center of the Navy. Admiral Taylor, who is a member of the Aircraft Production Board, has the facts concerning the developments abroad and the country is relying on his great ability to present a program of naval expansion which will make the Navy of definite assistance to our Allies.

Up to now the planning for the development of our aircraft has been in the hands of Army and Navy officers and the Aircraft Production Board. It is expected that their recommendations will be made early in July. The burden will then rest on Congress. Up to last August Congress had been unwilling to appropriate any substantial sum for aeronautics, but since then it has practically given the sums requested by the Army and Navy. Now, with the public alive to the needs of our Allies, and with them looking to us for the one great service we can render in this war, Congress will probably follow the best advice it can secure and establish an air service which will be able to deal a decisive blow for democracy.

Orders to Manufacturers

The significant fact of the meeting of the Society of Automotive Engineers in Washington which seven hundred busy manufacturers attended was that the automobile industry was looking to the aircraft motor to make up for any falling off of the use of pleasure cars.

Rumor in Washington has it that a man prominent in the automobile world and with full knowledge of the probable needs of the Government has stated that within six months the steel and mechanical equipment now being used to build automobiles will have to be diverted to the manufacture of motor trucks, airplane engines and other military and naval equipment.

If this is true it is but natural that automobile manufacturers are keenly alive to the present situation. Arrangements are under way to utilize some of the largest plants in the country for the production of integral parts of aircraft. Struts and propellers are desired from a talking machine company, fittings from a cash register organization, while accessories of all kinds will be sought from manufacturers who are able to turn their mechanical equipment to this purpose.

Through the present arrangement the final assembly of the airplanes will be under the supervision of the present constructors who know the intricacies of aircraft. It is to be hoped that the industry will meet the national emergency with the skill it has already shown.

Our Aviators Abroad

The announcements of the arrival of American aviators abroad have been rather misleading if the public assumes that these representatives of our flying services are all trained fliers.

We cannot go into details as to the particular purposes for which these aviation groups were sent but the announcement of the landing of "one hundred naval aviators" is more inspiring than accurate.

If it is desired that publications suppress all news of the movement of troops, it is to be hoped that such news as is given out will be authentic and correct.

The Patent Situation

The National Advisory Committee for Aeronautics is expected to make an announcement in a short time regarding the work accomplished by the Sub-Committee on Patents.

From all the information available at this time it appears that the committee has reached a satisfactory solution of this complicated and important problem. Substantial recognition has been given to the valuable work of the Wrights, Glenn Curtiss, Burgess and Glenn Martin.

When the final decision has been made on this matter, which has been pending so long, the whole industry will feel indebted to the National Advisory Committee for handling this question without the tedious delay which court proceedings would have involved.

The Power Plant from the Consideration of Airplane Performance

By Donald W. Douglas

Aeronautical Engineer, S.S.I.

The question of the power of the engine which will best give the performance desired for certain specified duties of a military airplane is one which has been subject somewhat to conjecture, in particular, by those developing engines. So far this question has not confronted the designer in this country, for his choice of engines is limited by the small number available.

An attempt will be made here to indicate, in general, the most suitable power to be employed in military machines of two classes, i.e., the one-place pursuit machine and the two-place reconnaissance, or bombing machine.

One-Place Pursuit Machine

Characteristics

One-place, tractor biplane.
Aspect ratio, six.
Span of upper and lower wings equal.
Gap chord, one.
Factor of safety of wing section, 5½.
Wing section, U. S. A. No. 1.
Low speed, 55 m.p.h.
Wing loading 8.45 lb. per sq. ft.

Requirements

2¼ hours flight at full power.
250 lb. military load (pilot, gun and ammunition).

Estimation of Weight

First Approximation

Assuming weight of power plant is 3 lb. per horsepower, and assuming this weight to include engine, radiator, water and exhaust manifolds, if any.

(1) Power plant weight $= 3 \times h.p.$

(2) Propeller weight $= 2.5 \times \sqrt{h.p.}$

(3) Assuming the same fuel consumption—fuel and oil weight for 2¼ hrs. $= 1.40 \times h.p.$

(4) From average of a number of successful pursuit machines—body weight, comprising engine mounting, structural body weight, cowling, covering, seats, control operators, and tail skid $= 1.84 \times h.p.$

(5) Chassis weight $= 0.7 \times h.p.$

(6) Military load = 250 lb.

(7) Tail surface weight $= \dfrac{12 \times h.p. \times .19 \times .9}{8.45} = 0.25\ h.p.$

(8) Oil and gas tank weight with piping $= \dfrac{h.p. \times 1.40 \times 1.8}{6}$

$= 0.42\ h.p.$

Assuming the weight of wings, plus flaps, plus struts, cables and fittings is 1 lb. per sq. ft., net lift of wings $= 8.45 - 1 = 7.45$ lb. per sq. ft.

(9) Weight of wings = area of wings $=$

$$\frac{7.61\ h.p. + 2.5\sqrt{h.p.} + 250}{7.45}$$

and the total weight of the machine fully loaded is W.

(10) Where $W = \dfrac{8.45}{7.45}(7.61\ h.p. + 2.5\sqrt{h.p.} + 250)$

Weights by Second Approximation

Assuming the net area of the wings is 92 per cent of the area $- 2 \times$ wing span $\times$ chord, to allow for cut outs and body, and assuming the aspect ratio 6, is based on span of wings measured along center of chord.

The span $= \sqrt{\dfrac{6.22}{7.45}(7.61\ h.p. + 2.5\sqrt{h.p.} + 250)}$. Now from good practice we may write, overall length of machine $= 0.79 \times$ span, therefore overall length $=$

$$.519\sqrt{7.61\ h.p. + 2.5\sqrt{h.p.} + 250}.$$

From an average of a number of machines of this type, we may write body weight (as per item (4)) = (overall length of machine)$^2 \times .0044 \times h.p.$, then body weight $= 0.269 \times (7.61\ h.p. + 2.5\sqrt{h.p.} + 250) \times h.p.$, which may finally be written as

(1) Body weight $= .00902\ h.p.^2 + .00296\ h.p.^{3/2} + 0.296\ h.p.$ as before:

(2) Power plant weight $= 3 \times h.p.$

(3) Propeller weight $= 2.5 \times \sqrt{h.p.}$

(4) Fuel weight $= 1.4 \times h.p.$

(5) Chassis weight $= 0.7 \times h.p.$

(6) Military load = 250 lb.

(7) Tail surface weight $= \dfrac{.2 \times .9}{7.45}(7.61\ h.p. + 2.5\sqrt{h.p.} + 250)$ or $= (.184\ h.p. + .06\sqrt{h.p.} + 6)$.

(8) Tanks and piping $= 0.42\ h.p.$ and the total loaded weight of the machine:

(9) $W = \dfrac{8.45}{7.45}(.00902\ h.p.^2 + .00296\ h.p.^{3/2} + 6\ h.p. + 250\ h.p.^{1/2} + 256)$

or $W = (.01023\ h.p.^2 + .00336\ h.p.^{3/2} + 6.8\ h.p. + 2.90\ h.p. + 290)$ also

(10) $\dfrac{W}{h.p.} = (.01023\ h.p. + .00336\ h.p.^{1/2} + 6.8 + 2.90\ h.p.^{-1/2} + 290\ h.p.^{-1})$, and differentiating

(11) $\dfrac{dW}{d(h.p.)} = (.01023 - .00168\ h.p.^{-1/2} - 1.45\ h.p.^{-3/2} - 290\ h.p.^{-2})$

Solving (10) for different values of $h.p.$, curve I is plotted in Figs. I, II, III. Equating (11) to zero and solving, we find that the power of the machine which will have the minimum value of $\dfrac{W}{h.p.}$ is 173 $h.p.$

It may be proven as follows, that the machine with the lowest weight per horsepower will be the one with the greatest speed range and maximum climbing rate.

Assumptions

Parasite resistance varies directly as the total loaded weight and as the square of the velocity.

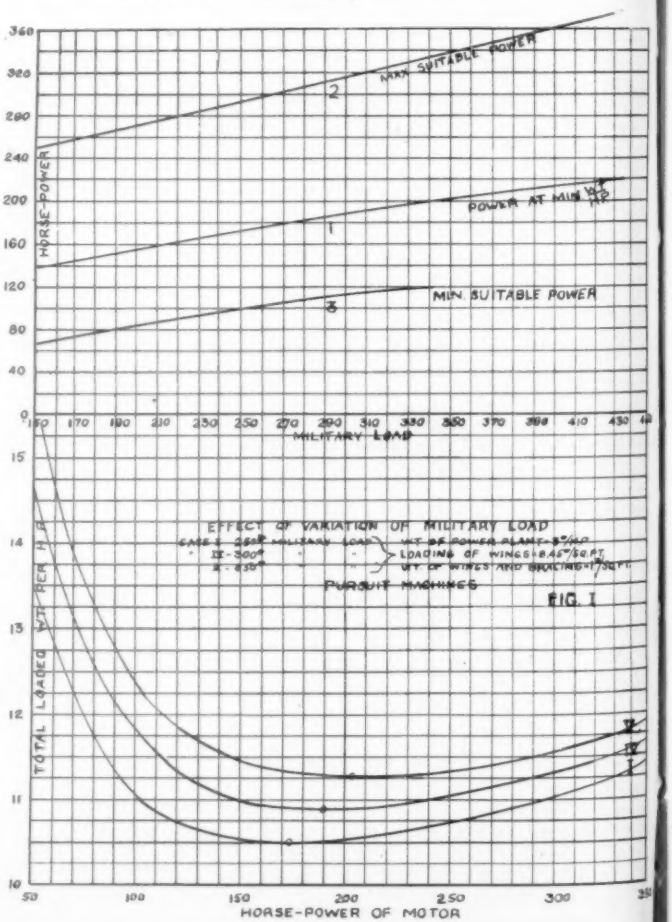


FIG. 1

The curve of propeller efficiency plotted against speed is the same for all powers.

The wing resistance RW may be expressed $RW = A \times Kx \times V^2$

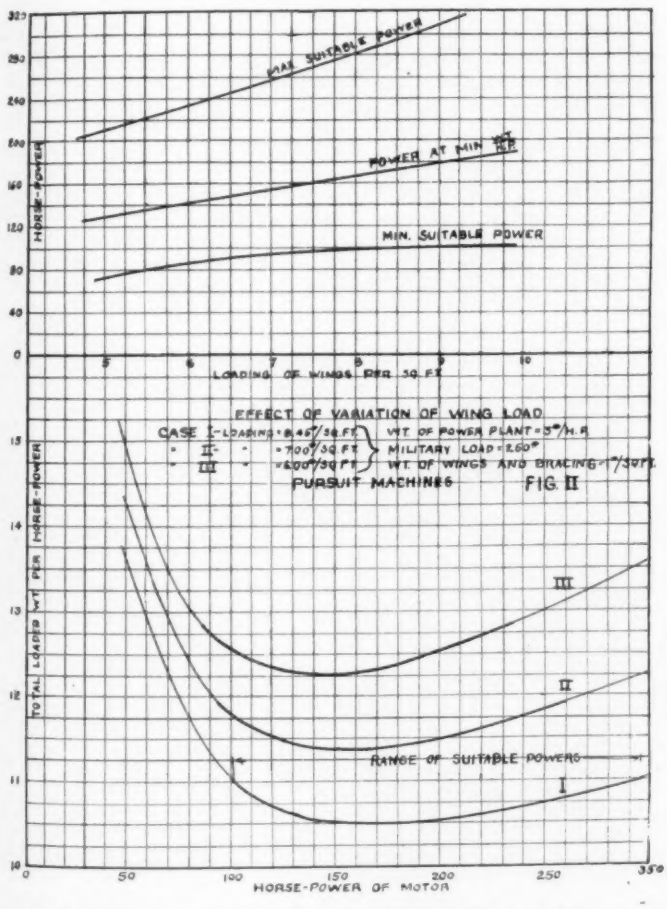
Since the loading is the same for machines of different power, at any one speed, the wing resistance, RW, varies directly as the area, A. Also, the power, PW, necessary to overcome the resistance of the wings, varies, for the same speed, directly as the wing area.

Now we have assumed that the parasite resistance varies directly as the total weight of the machine. Therefore, the power, P_p, necessary to overcome parasite resistance, varies directly as the weight.

But the total weight varies directly as the area, since the loading of the wings is the same for all powers. Therefore P_p varies directly as the area. We can then write, for any one speed $Pw = \frac{V^3 \times Kx}{550} \times A = K_1 \times A$, also, assuming $C =$ parasite coefficient at unit value of A and unit value of V, $P_p = \frac{C \times V^3}{550} \times A = K_2 A$, also $P_t = Pw + P_p = (K_1 + K_2)A = K_t A$, also $\frac{P_t}{h.p.} = K_t \times \frac{A}{h.p.}$

But we have already found that $\frac{W}{h.h.p.} = 8.45 \frac{A}{h.h.p.}$, therefore the minimum value of $\frac{P_t}{h.p.h.}$ occurs at the same magnitude of $h.h.p.$ as the minimum value of $\frac{W}{h.h.p.}$.

Therefore, that machine of engine power corresponding to that giving the least total weight per horsepower will be the machine with the greatest speed range.


MAX. SUITABLE POWER
POWER AT MIN. SPEED
MIN. SUITABLE POWER
HORSE-POWER
LOADING OF WINGS PER SQ. FT.
EFFECT OF VARIATION OF WING LOAD
CASE I - LOADING = 8.45 / SQ. FT. WT. OF POWER PLANT = 3 / H.P.
II - " = 7.00 / SQ. FT. MILITARY LOAD = 260
III - " = 5.00 / SQ. FT. WT. OF WINGS AND BRACING = 7 / SQ. FT.
PURSUIT MACHINES FIG. II
TOTAL LOADED WT. PER H.P.
RANGE OF SUITABLE POWERS
HORSE-POWER OF MOTOR

It is obvious that the climb rate will also be a maximum at this power.

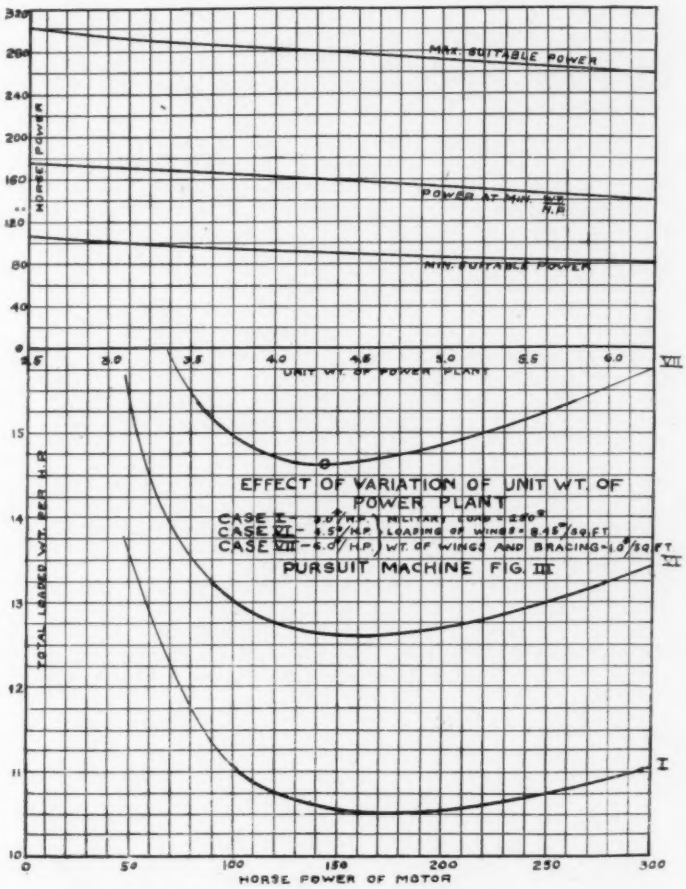
In order to show the effect of changes in the requirements of the machine, four other curves have been drawn, following the same method of procedure.

In Fig. I are plotted the curves of total loaded weight per horsepower against engine power, for three different military loads. From these three curves are plotted three curves of engine horsepower against military load.

Curve 1 shows the variation of the engine power for minimum values of total loaded weight per horsepower, with a change in the military load.

Curves 2 and 3 show the maximum and minimum limits to the range of suitable powers for various military loads. By suitable powers is meant those powers the use of which will entail an increase in the value of total loaded weight per horsepower not greater than 5 per cent of the minimum weight per horsepower.

In Fig. II, curves are drawn as in Fig. I, to show the effect of a variation of the low speed, or of the wing loadings, depending on whether the same or different wing sections are used.


MAX. SUITABLE POWER
POWER AT MIN. SPEED
MIN. SUITABLE POWER
HORSE POWER
UNIT WT. OF POWER PLANT
EFFECT OF VARIATION OF UNIT WT. OF POWER PLANT
CASE I - 3.0 / H.P. MILITARY LOAD = 260
CASE VII - 4.5 / H.P. LOADING OF WINGS = 8.45 / SQ. FT.
CASE VIII - 6.0 / H.P. WT. OF WINGS AND BRACING = 1.0 / SQ. FT.
PURSUIT MACHINE FIG. III
TOTAL LOADED WT. PER H.P.
HORSE POWER OF MOTOR

In order to indicate the effect of the use of heavier power plants than those used in plotting the curves in Figs. I and II, curves are plotted in Fig. III for three different weights of power plant per horsepower.

General Conclusions

It must be realized that, in pointing out the following conclusions, there is no desire to hold too rigidly to the best powers to use. In our assumption, it was necessary to take mean values of all coefficients, and hence there will be cases where, using one designer's methods of construction, the best power to employ will be different from that derived by using some other constructor's characteristic design.

From Fig. I it is apparent that the engine power should be increased with an increase of military load. The increase of the best power and of the limits to the range of suitable powers is, however, not very great, and hence it appears that with careful design, good performing pursuit machines can be built around engines of from 120 to 290 h.p., with a best mean power of about 185 h.p. for any military load between 250 and 350 lb. Notice must be taken that these results are only for power plants weighing 3 lb. per h.p. and for a wing loading of 8.45 lb. per sq. ft. This comparison then is for air-cooled engines, and fast pursuit machines.

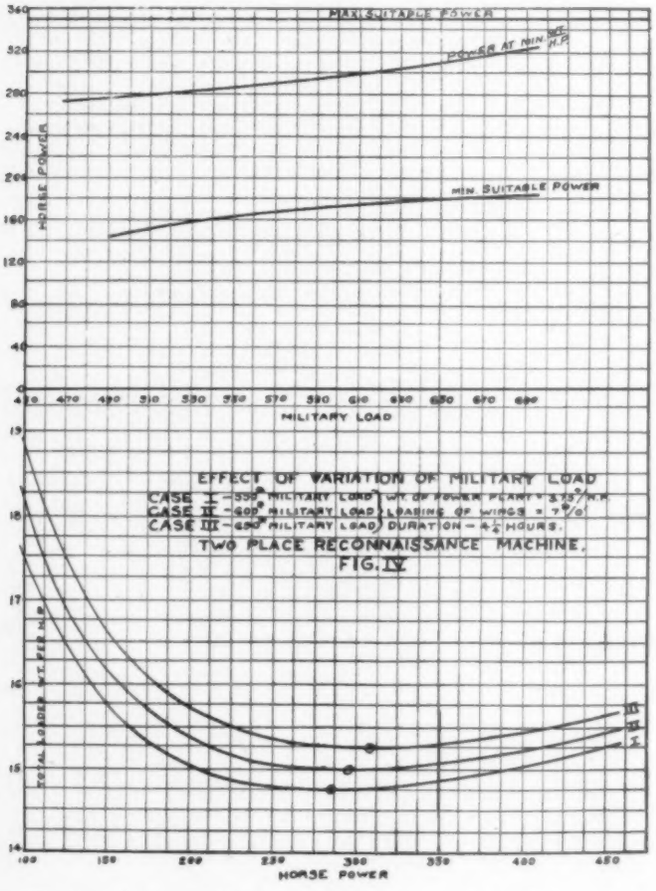
From Fig. II it is apparent that the slower the speed of the machine (using a section similar to U. S. A. No. 1, as to maximum lift), the lower will be the best power to employ. Also, if the machine is to be built for maximum speed range, which

will necessitate the use of a fine, low lift wing section rather than for maximum climb, the best power plant will be of less power.

The best mean power, from these three cases, seems to be in the neighborhood of 160 h.p., with a range of suitable powers for all cases of from 100 to 240 h.p.

Fig. III indicates that the use of a power plant of heavier weight per horsepower than 3 lb. lowers the value of the best power to use. The best mean power from these three cases of power plant weight is about 160 h.p.

Combining roughly the results of Figs. I and II, we may say that the air-cooled engine for speed scouts of various probable requirements and designs should be of about 170 h.p. With little loss in the overall performance of the machine, this power may vary from 120 to 240 h.p. Since handiness and commercial advantages favor small machines, we may find that a compromise, say, 150 to 160 h.p., will give the best all-around results with light air-cooled, or if it is possible, water-cooled engines.


MAX. SUITABLE POWER
POWER AT MIN. WT. H.P.
HORSE POWER
MILITARY LOAD
EFFECT OF VARIATION OF MILITARY LOAD
CASE I – 550# MILITARY LOAD
CASE II – 600# MILITARY LOAD
CASE III – 650# MILITARY LOAD
WT. OF POWER PLANT = 3 1/3 #/H.P.
LOADING OF WINGS = 7 #/SQ. FT.
DURATION – 4 1/2 HOURS.
TOTAL LOADED WT. PER H.P.
HORSE POWER
TWO PLACE RECONNAISSANCE MACHINE.
FIG. IV

Taking the other limit, power plants running 6 lb. per h.p., which we may say is the case with many water-cooled engines today, the best size of power unit to employ will be about 140 h.p., and may vary from 100 to 240 h.p. Here, to economically fill up the body, and thus get the most power in a body of approximately the same cross-sectional area, and hence with about the same resistance; and to take account of the fact that an engine of this weight would probably be used only where more duration was required, we should favor the engines of greater power than that indicated as the best by the foregoing calculations. Taking into account all these considerations, we may say, roughly speaking, that 200 h.p. will be the most efficient power to employ.

Two-Place Reconnaissance Machine

Characteristics

Two-place, tractor biplane.
One engine and one propeller.
Aspect ratio, seven.
Span of upper and lower wings equal.
Gap/chord, one.
Wing section, U. S. A. No. 1.
Low speed = 50 m.p.h.
Loading of wings, 7 lb. per sq. ft.
Factor of safety of wing system, 6.5.
Weight of power plant, comprising engine, radiator, water and exhaust manifolds = 3.75 lb. per h.p.
Gas and oil for 4¼ hours endurance = 2.55 lb. per h.p.

General Method

Three cases were taken from which curves I, II and III in Fig. IV were drawn. The only variable was the military load, which was taken as 550, 600 and 650 lb. respectively.

The method of estimating the weight in each case was similar to that employed in the case of the pursuit machine, but with those changes in the various coefficients which were indicated by data on machines of this type.

Since the military load varies in certain increments rather than in proportion to size or power of the machine, the military load was varied by the same amount, i.e., 50 lb., as was done in the case of the pursuit machine. As may be expected, Fig. IV shows that the variation of the military load in the reconnaissance machine has less effect on the choice of the power plant than in the case of the pursuit machine.

General Conclusions

The most efficient size of power plant for the average value of military load seems to be in the neighborhood of 300 h.p. Power as low as 180 h.p. may be used with but 5 per cent increase in the value of total weight per h.p. The upper limit of the range of suitable power is beyond the present-day possibilities. The maximum power that it appears possible to safely and economically transmit by one propeller would be about 350 h.p. This limit lies well within our range of economical powers.

It has not been thought necessary to extend the investigation of the variation of best power for this type machine as was done with the pursuit machine. Approximately, the same proportional effect would be found, for a variation of the wing load, as was found with the pursuit machine. A decrease of wing loading will, as before, decrease the value of the most economical power.

A variation of the weight of the power plant per horsepower will also, as before, tend to lower the magnitude of the most economical power, but it is well to notice that the proportional decrease in this value will be less than in the case of the pursuit machine, as the proportion of the increase in power plant weight to the total weight of the machine is less.

The Kite Balloon in War

The observation balloon has been one of the important discoveries of the war. Its value is indicated by the rapid growth of both personnel and craft. It is found to-day on every front, and almost every mile of that front, for the excellent reason that it has proved indispensable to the modern army in the field.

The observation kite balloon, as at present used, was the invention of Capt. von Sigsfeld and Major von Parseval, of the German army, and the craft were constructed by the Parseval Airship Co. The British army got its first idea of the kite balloon from the Belgians. Early in 1915, Squadron (now Wing) Commander Maitland was so much impressed by the excellent service it was giving the Belgian artillery that he laid a proposal for similar equipment before the Board of Admiralty. This was adopted; orders for the construction of the craft were placed, and the British K-B made its first appearance in the war area in the early spring of 1915.

As then constructed by the British, the balloon was found to be considerably more reliable than the spherical, being steadier and more air-worthy, and therefore more accurate in observation.

The great success of the first craft led to a demand for more, and the British naval authorities made experiments with them on ships at sea. More and more urgent grew the demand from both branches of the service, until to-day kite balloons form an important part of both naval and military forces.

The work of these craft is too widely recognized to need repetition, further than to mention the danger to which a captive balloon is exposed from hostile airplanes. There is not often time enough to draw the balloon to the ground when an enemy machine appears, and the only protection is a friendly airplane, or the ever-ready parachute.

Course in Aerodynamics and Airplane Design

By Alexander Klemin, A.C.G.I., B.Sc., S.M.

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and

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PART II—SECTION 10

Computation of Strength Members and General Layout of Body

In designing tension members for the body, no feature is of greater importance than the choice of terminal fastenings which will permit the development of as large a percentage as possible of the true strength of the wire or other tension member.

The main points to be considered in dealing with terminal connections are:

(1) The efficiency, as mentioned above.

(2) Quickness and ease of manufacture.

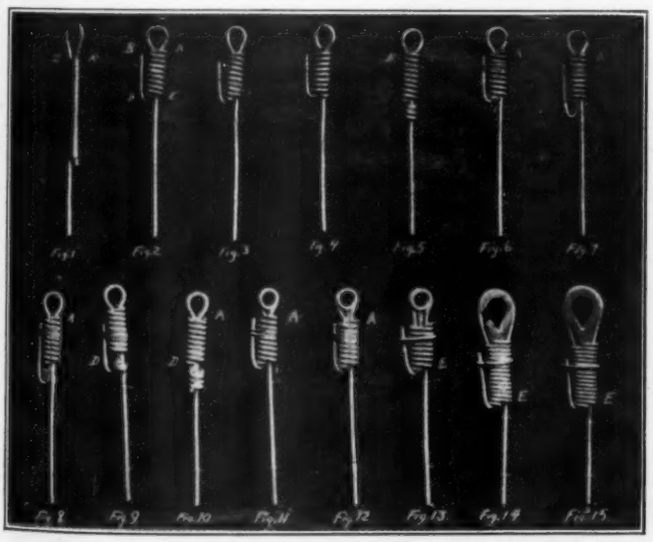
(3) The possibility of easy and efficient repair or replacement in the field.

(4) Reliability, i.e., the difference in efficiency between the best and poorest terminals of a series all made up in the same way should be as small as possible.

(5) The possibilities of defects due to the use of acid and solder, overheating, imperfect bends, flattening of wire on bends, or unskillful handling of the material in the field. This requirement is obviously closely allied to that of reliability.

Extended tests on terminal connections of all types have been made by John A. Roebling's Sons Co. A summary of the most important results is given herewith, and reference to the original report is appended.

The first series of tests related to hard-drawn aviator wire. The form of terminal which was most common up to a few years ago, consisting of a ferrule made from a coil of wire, through which the wire is passed and then doubled back on itself (Figs. 2 and 3), gave very poor and uneven results, the efficiency varying from 60 to 75 per cent, with an average of 65 per cent. These efficiencies were improved by about 5 per cent when the free end of the wire, instead of being doubled back outside the ferrule, was wound three times around the standing portion of the stay.



FIGS. 1-15. TERMINAL FITTINGS FOR SOLID WIRE, TESTED BY JOHN A. ROEBLING'S SONS CO.

The next type of terminal tested was similar to the last, but was dipped in solder after being made up (Fig. 1). The ferrule for such a connection may be made of a coil of wire, as previously, or of a strip of thin sheet metal, wrapped around both portions of the wire. The efficiencies obtained ran from 60 to 90 per cent, with an average of 80 per cent. These values are surprisingly low, and indicate probable damage of the wire by overheating in the process of soldering, as a connection such as this, absolutely preventing any slippage of the wire through the ferrule, should always show 100 per cent efficiency if properly made up. Tests on similar terminal fittings at the Massachusetts Institute of Technology have nearly always developed the full strength of the wire, the stay breaking near the center on every test. The soldered joints have, however, the disadvantage that they cannot readily be replaced in the field, and they are peculiarly susceptible to poor workmanship, the effects of which cannot be determined in any way until the break actually comes.

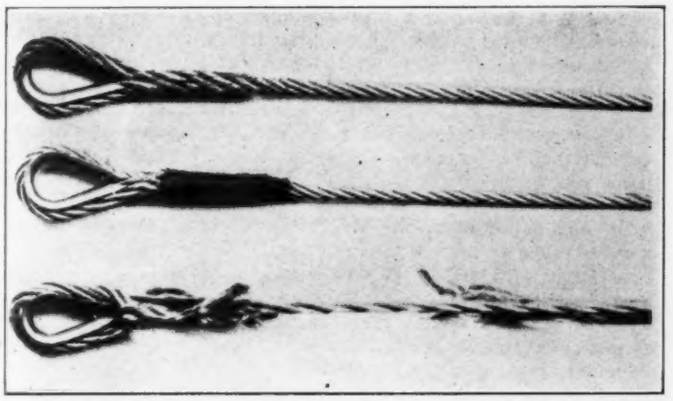


FIG. 16. SERVED AND UNSERVED SPLICED JOINTS AND TYPICAL FRACTURE IN AVIATOR CORD.

In the Roebling tests, the best results were secured by the use of tapered ferrules, winding a coil of wire into the form of a slightly flattened cone instead of a flattened cylinder, in conjunction with wedges designed to increase the friction between the stay and the ferrule as the pull increased. Such wedges may be separate members, fitted between the eye and the ferrule, in which case the wire is looped completely around to make a double eye, or they may be embodied as a part of the thimble, which is interposed between the fittings and the eye to prevent any change in shape or size of the eye under strain. No solder whatever is used (Figs. 13-15). The efficiencies obtained with such terminals were very uniform, ranging only from 92 to 96 per cent, with an average of 94 per cent. Such a terminal, although necessarily somewhat complex, has marked advantages. It can readily be made up in the field, and there are unlikely to be hidden defects, any slipshod workmanship being instantly apparent on inspection.

The British standard, which has recently been adopted by the Society of Automotive Engineers, calls for the use of the plain wire coil ferrule with solder. A device which has been considerably used in England, although not yet employed in this country, is the streamline wire with swaged and threaded ends, thus doing away with the necessity for turnbuckles. Such wires are very expensive and difficult to make, but have decided advantages in practice. They are unlikely to come into use except for fighting machines, where cost is of no importance.

Cable Terminals

Both strand and cord can be spliced with excellent results if the work is done by an expert rigger. Roebling's tests indicated an efficiency of from 80 to 85 per cent for aviator cord

with spliced and served terminals (Fig. 16), and from 90 to 100 per cent, the highest values corresponding to the smallest wire sizes, for 19-wire aviator strand (Fig. 17). The break

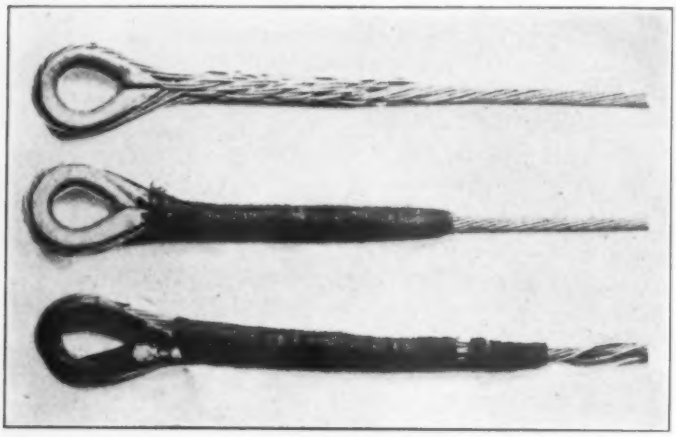


FIG. 17. SERVED AND UNSERVED SPLICED JOINTS AND TYPICAL FRACTURE IN AVIATOR STRAND.

always occurred at the last tuck in the splice, which would suggest the advisability of tapering the splice to a greater extent.

For field connections, fittings similar to those recommended for solid wire, consisting of a thimble embodying a wedge and a ferrule of soft wire (Fig. 18), gave excellent results, showing an efficiency of 90 per cent.

The status of solder is the same as in the case of solid wire. 100 per cent efficiencies can be secured by the use of thimble, ferrule, and solder with either strand or cord, but there is the same risk of injury to the material through improper manipulation.

In connection with the larger diameters of strand, sockets may advantageously be used (Fig. 19). They give 100 per cent efficiency, or very nearly; they require no high degree of skill to apply, and the fitting is neat and simple in appearance. The common type consists of a conical shell, the hole in the small end being just large enough to admit the strand. The strand is passed through this hole for a short distance, unravelled, and the ends spread out as much as possible. The conical shell is then poured full of solder, and the ends of the component wires cut off flush with the large end of the shell. The only danger in the use of such a fitting arises from the liability to deterioration of the solder.

As we mentioned in the preceding section of the Course, the stress diagram which was then drawn does not form a complete basis for the choice of members, but should be supplemented by various other diagrams corresponding to different conditions of loading. We shall, therefore, confine ourselves to figuring, for purposes of illustration, a few of those members which are most heavily stressed under the conditions which we have already considered.

Since a dynamic load factor of 8 has already been allowed for, we shall use a factor of safety above this of only one and a half. This is equivalent to an overall factor of safety, relative to the static load, of twelve, a value which is fairly representative of modern practice in the design of bodies for training machines. The latest specification issued by the Government calls for an overall factor of ten, but this relates to pursuit machines, which are to be flown by skilled pilots only, and in which the factor of safety is purposely kept low in order to make possible a better performance, and hence a higher degree of military safety. In the case of those portions of the longerons which are curved to a considerable extent between struts, the factors of safety should be considerably increased, as a strut which has even the slightest sign of initial curvature will support much less load than one which is perfectly straight.

FIG. 18. UNSOLDERED FIELD TERMINAL FOR AVIATOR STRAND.

The members for which we shall compute the required size include a longeron section, a strut, and a wire, and they are marked with numbers on the layout drawing. We shall consider all compression members as perfectly square, although channeling is commonly employed, especially in struts and the rear portions of the longerons.

(1) The length of the section is 40 in. We shall try, as a first assumption, a section 1¼ in. square. The crippling load is then $17.44 \times 1{,}825{,}000 \times \frac{(1\frac{1}{4})^4}{40^2 \times 12}$, or 4,050 lb. This corresponds to a factor of safety of $\frac{4{,}050}{2{,}070}$, or 1.95, above the dynamic loading. We shall, therefore, use this section. It is well to have the factor in the longerons slightly greater than in the

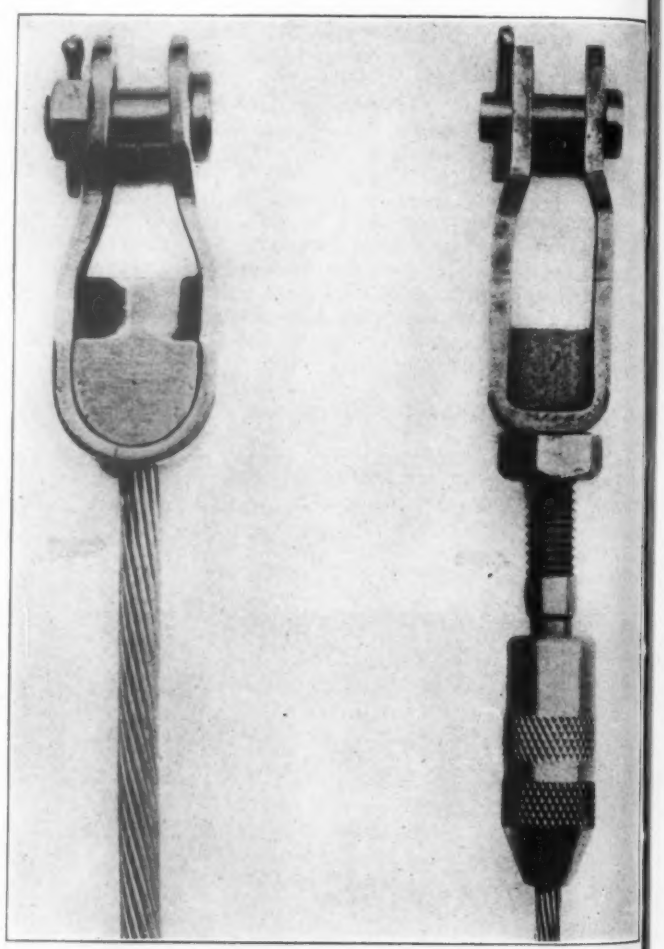


FIG. 19. SOCKET TERMINALS FOR AVIATOR STRAND.

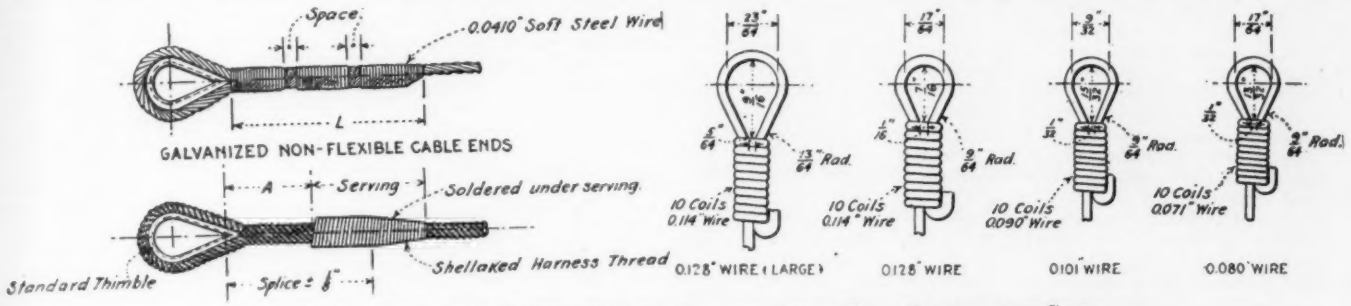
struts, since their end conditions approach less closely to fixation.

(2) The length of the strut is 31 in., and the compressive load is 3,900 lbs. Here, again, a section 1¼ in. square will be tentatively chosen. The crippling load equals $17.44 \times 1{,}825{,}000 \times \frac{(1\frac{1}{4})^4}{31^2 \times 12}$, or 6,740 lb. The factor of safety is then 1.72.

(3) The tensile load is 3,400 lbs. We shall select for this stay 19-wire strand $\frac{3}{32}$ in. in diameter. The breaking load of such strand is 6,100 lb., and the factor of safety, allowing for 90 per cent efficiency of the terminal connections, is 1.61.

The struts which carry the weight of the engine should be materially heavier than would be indicated by considerations of dead loading alone, since they are constantly submitted to

a live, vibrative load, and, in addition, are subjected to bending forces because of the gyroscopic action in diving. These forces



FIGS. 20, 21, 22. S. A. E. STANDARD TERMINALS FOR SOLID WIRE, STRAND, AND CORD.

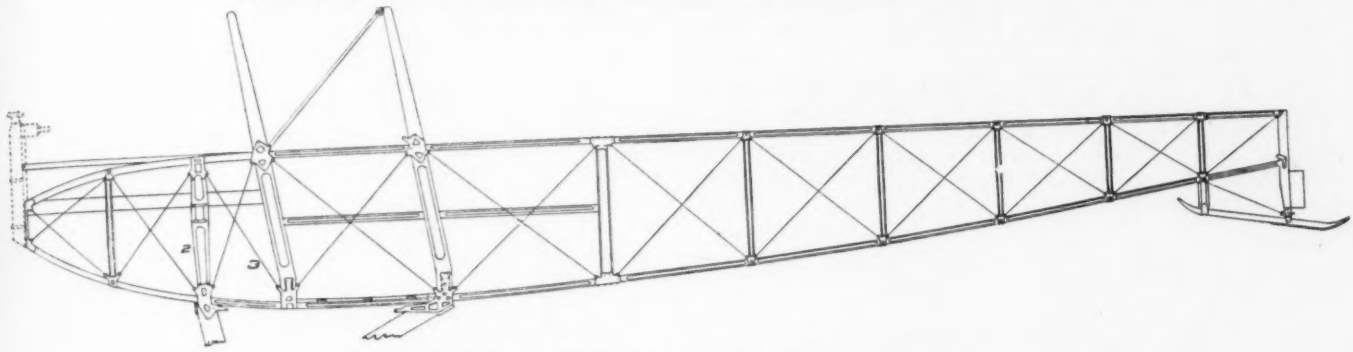


FIG. 23. LAYOUT OF BODY FOR STANDARD TRAINING MACHINE.

are calculable, but such an analysis is beyond the scope of this paper.

In Fig. 23 is shown the layout of the body. The only points at which channeled struts are used are the forward panels, which have the duty of transmitting the propeller thrust to the longerons, and thence to the wings. The other struts are made octagonal by chambering off the corners slightly. The longerons are channeled everywhere in back of the forward chassis strut, except that they are left solid for a few inches adjacent to every strut.

References

First Annual Report of the National Advisory Committee on Aeronautics, Report No. 2; Government Printing Office, 1916.

Allowances for Bending Sheet Metal

By Randolph F. Hall

Of the Thomas-Morse Aircraft Corp.

It is an important point in the design of fittings to make correct allowances for bends in sheet metal. The writer, together with B. D. Thomas, has carried out a number of measurements on bends round a 1 in. square bar, and the results are embodied in the chart of Fig. 1, on lengths measured along the neutral axis.

A number of strips, eighteen, sixteen, fourteen and twelve gage sheet steel, were bent over a 1 in. square steel bar, with corners rounded in each case with the radius equal to the thickness of the metal. Had no allowance been required for bending, the ends of the strip would have met in the center of a face of the bar, but instead a gap resulted, which divided by four gave actual allowance for one bend. The allowances required per bend were between thirty-three hundredths and thirty-eight hundredths times the thickness of the metal, and the mean of ten different tests confirmed the allowances computed on the neutral axis. From these experiments the curves of Fig. 1 were deduced, allowances for angles less than 90 deg. being made proportionately.

Results in the factor verify the chart. If the courses are hammered flat, less allowance is required, but the fitting is weakened.

(*Editorial Note.*—It would be very interesting to obtain figures from other firms, where similar measurements have been made.)

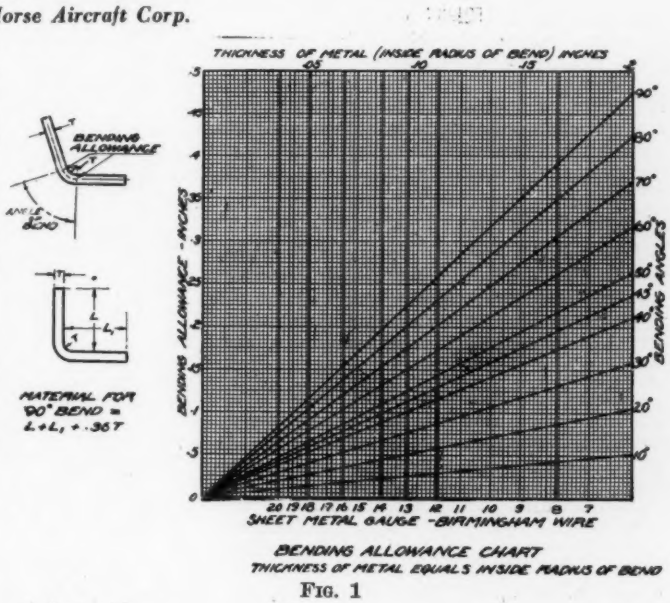

BENDING ALLOWANCE
ANGLE OF BEND
MATERIAL FOR 90° BEND = L+L₁+.36T
THICKNESS OF METAL (INSIDE RADIUS OF BEND) INCHES
BENDING ALLOWANCE - INCHES
BENDING ANGLE
SHEET METAL GAUGE - BIRMINGHAM WIRE
BENDING ALLOWANCE CHART
THICKNESS OF METAL EQUALS INSIDE RADIUS OF BEND

FIG. 1

Aeronautical Patents

Copies of these patents may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."

ISSUED JUNE 19, 1917.

1,230,620. Filed July 11, 1916. To Frank E. Summer, Memphis, Tenn. Airplane.

1,230,641. Filed April 21, 1913. To Vincent Ajello, Pittsburgh, Pa. Airplane.

1,230,443. Filed July 2, 1913. To John P. Tarbox, Buffalo, N. Y., assignor to Tarbox Safety Aircraft Co., a corporation of Delaware.

1,230,526. Filed July 12, 1910. To John Thomas Simpson, Newark, N. J. Flying machine.

1,228,390. Filed Feb. 1, 1916. To Louis Bêchereau, Paris, France, assignor to The Society Spad Societé Anonyme pour l'Aviation et ses Derivés. Airplane.

1,228,705. Filed March 6, 1911. To Osam Shudow, San Francisco, Cal. Airplane.

1,228,729. Filed Sept. 15, 1916. To William Frances Williams, Leadwood, Mo. Airplane.

Glue for Use on Airplanes*

By Percy A. Houseman

There are many parts of an airplane that require the use of an adhesive material. Of these may be mentioned "airscrews" (the collective name for propellers and tractors), hollow spars, booms, ribs, plywood, etc. For some of the small parts, such as the ribs, which are subsequently covered by "doped" fabric, it is not necessary to use the best quality of glue. For other parts, however, it is of vital importance that only the strongest glue be used. This applies particularly to airscrews, which rotate at a very high speed.

Airscrews are built up in laminae of walnut or mahogany, usually 7 in number, and each 1 in. thick. It is usual to glue two laminae together, and allow them to remain in clamps for a period of from 6 to 24 hrs. before gluing on the next lamina. The finished airscrew is shaped out after the total number of layers have been glued together and have been allowed to set. The glue is applied hot, and usually by at least two workmen, in order to cover the surface as quickly as possible. The temperature of the gluing room is kept above 70 deg. Fahr. It would, of course, be an economy to glue at one operation all of the laminae of an airscrew, but this is not possible when a cake glue is used, on account of the rapidity with which the hot solution sets. Attempts have been made to overcome this difficulty by the use of "liquid" glues, but these have usually proved unsatisfactory. One French liquid glue contained some hygroscopic material, and failed to set in 14 days. "Liquid" glues should be used only on work in which great strength under widely varying conditions of temperature and humidity is not of prime importance. Bone glue should never be used on aircraft work. The best results are obtained from skin or hide glues.

In working out a method for the examination of glue some attention was given to such chemical and physical tests as moisture, ash, nitrogen, strength of jelly, viscosity, percentage precipitable by alcohol (Stelling's test), etc., but while the information furnished by these tests was of interest, it was not found possible to correlate definitely the results obtained, with the value of the glue for airplane work.

A method was therefore developed to test the strength of a glued joint under various conditions. Experiments were made with blocks of biscuit-ware, as recommended by Rideal in his book on "Glue and Glue Testing." Messrs. Doulton, of London, kindly made the necessary blocks, which had a base (*ab*) 1 in. square, similar in design to that shown in Fig. I.

Two such blocks were glued together under various conditions of strength of glue solution, temperature, method of application, pressure of clamping, etc. The blocks were pulled apart in a cement testing machine with automatic application of the load, but as uniform results could not be obtained, the stone blocks were abandoned. More uniform results were obtained with wood, which also has the advantage of giving results more nearly comparable with those obtained under actual service conditions. Pieces of carefully selected straight-grained walnut were used, and from them a number of different types of joints were prepared, and used to illustrate different kinds of stresses. The type of joint finally adopted is that shown in Fig. II. This joint gives by no means a true shear, as was easily seen by examining under polarized light a celluloid model made to scale. A stress more nearly approaching pure shear would probably be obtained with a joint like that shown in Fig. III, made up from pieces 9 in. × 2 in. × ¼ in. but for the purpose of obtaining comparative results, that shown in Fig. II answers well and has the advantage of simplicity.

BLOCKS AND JOINTS FOR GLUE TESTING

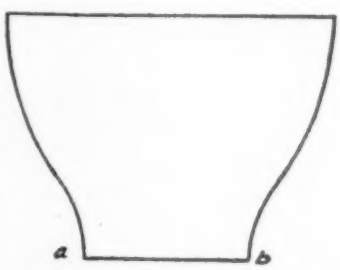


FIG. I

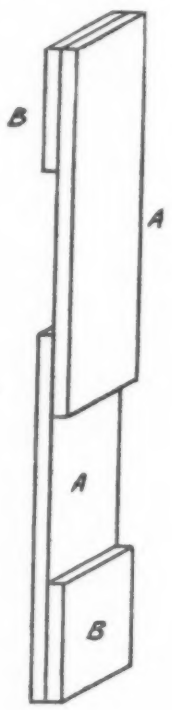


FIG. II

FIG. III

The wood is exposed for 24 hrs. to a temperature of 35 deg. Cent. before making the joint. The test pieces (*A*) are 9 in. × 2 in. × ⅜ in. These were roughened by a toothed plane, as it was found that a roughened surface gives a stronger joint than a smooth one. The distance pieces (*B*) are 3 in. × 2 in. × ⅜ in. The area of the glued surface of the joint to be pulled apart is 4 sq. in. To prepare the glue, it is broken into small pieces and is soaked over night in the requisite amount of water. For the gelatine types of glue, 1 part by weight of glue to 2 parts by weight of water gives a desirable concentration, while for "Scotch" glues 1 part of glue to 1.25 parts of water gives the best results. For other types of glue the water required usually falls within these limits. The soaked glue is dissolved by warming to 60 deg. Cent., and the solution is applied at that temperature. The joints are clamped under moderate pressure for 48 hrs., and are tested after a further 24 hrs. For each sample of glue, the following three tests, each in duplicate, are carried out on the joints prepared as described above.

Regular Test

The joints are pulled apart in a Buckton and Wicksteed or in a Riehlé (Philadelphia) Testing Machine and the breaking strain per sq. in. of glued surface is recorded. The experimental variation is less than + 10 per cent, most of which may be ascribed to unavoidable variations in the wood.

Heat Test

The joints are subjected to dry heat in an electrically heated oven for 2 days at 45 deg. Cent., and then pulled apart, and the breaking strain recorded.

Immersion Test

The joints are completely immersed in water at 20 deg. Cent. for 12 hrs., and are then pulled apart, and the breaking strain recorded.

The last two tests are intended to throw light on the behavior of an airscrew under the extreme conditions of a tropical climate and high humidity. Tests were also made with moist heat, and on immersion followed by dry heat, but were discontinued. The last named test was found to be too drastic, all glues giving very low results.

The whole procedure outlined above is an arbitrary one, and for this reason it is necessary rigidly to standardize and adhere to the technique of the method, in order to obtain comparable results. When the break occurs in the wood, as frequently happens in the regular test, one can, of course, only say that the glue is stronger than the wood, and record the figure at which the wood breaks.

Addition of phenol to the glue improves the regular test. The influence on heat tests and on immersion tests is not marked, but the tendency is to raise them slightly. The addition of 5 per cent phenol to a 1 : 2 gelatine solution, depressed the setting point of that solution from about 26 to 18 deg. Cent., while 10 per cent phenol caused the solution to be still viscous at 5 deg. Cent. The addition of 5 per cent phenol to glue solutions to be used on airplane work is, therefore, to be recommended, both because of its tendency to increase the strength of the joint, and also on account of its action in depressing the setting point.

Ammonia causes the glue to set more rapidly. It was found to have the unexpected effect of raising the figures for heat and immersion tests, while leaving regular tests little affected.

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* From the *Journal of Industrial and Engineering Chemistry.*

The Germans appear to have used a casein glue on some of their aircraft. An analysis of a Swiss glue of this type showed its composition to be about 66 per cent casein and 23 per cent mineral matter. The latter was composed of soda, silica, lime and alumina. About 1 per cent of petroleum was present in the powder. This casein glue is prepared for use by rubbing up with cold water. It requires about 3 days for the joint to set, but has the advantage that all the laminae of an airscrew can be glued together at once.

The following test figures were obtained on joints made with the Swiss casein glue:

Regular.		Dry Heat.		Moist Heat.		Immersion.	
551	655	526	661	448	465	672	862

The immersion test is particularly high.

Casein glues are very generally used for cementing together the "veneers" on plywood which finds extended use on the body and other parts of the airplane. One English firm uses a mixture of casein, lime, and blood, which yields a cement very resistant to water. A three-ply board made with such a cement will withstand an immersion test in water at 50 deg. Cent. for 12 hours without any separation of the plies, though the strength of this cement on a "regular" test is inferior to that of a hide glue.

Another firm of ply-wood manufacturers uses lime and casein only, in the proportion approximately of 4 parts by weight of lime to 7 parts by weight of casein. Casein and borax form a good mixture, but are, of course, more expensive than casein and lime. Casein glues cannot be kept more than a few hours after mixing with water, so that a batch when mixed must be completely used, or the residue wasted.

When a new glue is intended for use on airscrews, the tests described above should be supplemented by a practical test of spinning a trial airscrew made with the new glue.

TABLE I—INFLUENCE OF ADDITION OF PHENOL OR CONCENTRATED AMMONIA TO GLUE ON STRENGTH OF GLUED JOINT

Glue Tests:	Regular.		Heat.		Immersion.	
Gelatin A	644	627	459	...	504	...
Gelatin A + 5% Phenol	532*	616	476*	627	621	...
Gelatin A + 10% Phenol	677*	845	369	487	560	660
"Propeller" Glue	464	...	470	464	540	504
"Propeller" Glue + 5% Phenol	526	593	395*	506	553	560
"Propeller" Glue + 10% Phenol	610	632	315	429	560	565
"Scotch" Glue	548	571	448	470	448	470
"Scotch" Glue + 5% Phenol	688*	723	425	425	532	548
"Scotch" Glue + 10% Phenol	694	694	414	453	436	476
Gelatin A	627	644	459	565	504	549
Gelatin A + 2% Ammonia	610	655	616	688	800	875
"Propeller" Glue	464	...	464	470	540	504
"Propeller" Glue + 2% Ammonia	520	532	580	609	648	783

The figures represent breaking strain in lbs. per sq. in. of glued surface of the standardized joint. Breaks in the wood are indicated thus *.

Glue

By Dr. George F. Lull

It is not as easy as it would appear on the face of it to select a suitable glue joining two surfaces together.

There are many adhesives that are called "glue" that do stick together articles for use. We have a vegetable glue, made from starch, caustic soda and water, that will hold wood together under certain conditions. Gum Arabic and water glue papers. Casein, borax and water hold wood under hard conditions even and sometimes come under the waterproof glue class.

A glue, made from animal products, hide fleshings, sinews, bones and parts, is the true animal glue. It has the special property, that on cooling, or at its place in a joint it possesses a distinct film with the body and thus makes a better holding medium than many of the other adhesives which however thick they may appear when made up or applied, after drying out in the film or joint become extremely thin or fade away to almost nothing. This feature of the animal glue film gives it its great superiority over other compositions. Animal glue is a colloid of about the formula C_{70}, H_{124}, N_{24}, O_{29}. Much research work is being done today to discover more regarding it. The fact of its being an animal product is the great obstacle to the work.

Preparation of Glue for Work

A jacketed kettle is absolutely necessary for the proper dissolving and cooking of the dry glue. No glue should be mixed with water in a pan and melted—cooked—over a direct flame nor should a jet of live steam be used directly on the glue in a dissolving kettle because it will inevitably be burnt and its full value of adhesiveness destroyed.

In general all animal glue should first be soaked up in cold water, first putting all, or the larger portion of the full amount of water that is necessary for the solution of the glue into the kettle. Then the glue should be added slowly and continuously stirred with a wooden paddle so that it will be evenly liquified and no lumps of dry glue balls appear. This stirring may be continued at intervals, if necessary, to keep it well mixed.

When properly soaked up heat should be started and the contents of the jacketed kettle gradually warmed up. This is one of the vital points of the preparation of the glue. With the stirring the mass of glue and water should be gradually raised to a temperature of 140-150 deg. Fahr. and no higher, or the full strength of the glue will be lowered. It is not advisable to keep a batch of glue heated too long—say two or three hours as the extreme limit. It is better to use up a smaller making and keep the glue fresher, and not allow it to skim over or make a hard crust on its surface. Also it is better to make up only enough to use and when done, empty out the ketttle, clean it of all glue and then there will be no trouble with bad smelling glue.

Waterproof Glue

There are several chemicals that can be added to animal glue that will convert it on standing more or less into a waterproof glue. The resultant waterproof glue generally is a variable product and must be carefully watched in order to get concordant results, as a light variation in the chemical or a change in the glue stock used may produce widely varying results. Formaldehyd formalin HCHO is largely used and gives good results. This formaldehyde should be used very carefully—not over 5 per cent of the liquid solution at the most, and as low as 1 per cent with some glues has very good waterproofing effects. This formaldehyde must be added to the hot liquid solution of the glue just before using, making up only about enough for the work at hand as left over stock will be of no value, having set or hardened. The percentage should be computed as to the dry glue, i.e. 100 pounds dry glue to start with to one-half per cent of formaldehyde liquid.

The different bichromate-salts, ammonium, aluminum, ammonia, chromate, chromate of lime, bi-chromate of potash, chrome alum, etc., all containing chromates, can be used to good advantage to convert animal glue to an insoluble waterproof glue. Greater care in handling these products must be taken, with but little exposure to light and no overheating. The chromate must be dissolved in water and added to the glue mixture just before the removal from the kettle, or allowing only time for a thorough mixing at the point when ready to use.

One per cent of bi-chromate of potash would be a large dose, about the limit, i.e., 1 lb. chromate to 100 lb. glue. Smaller proportions can often be used, all depending upon the combination with the glue. This must be determined individually for each different sample of glue, care being exercised not to add such a quantity of the waterproofing element as to cause the glue to go stringy or liver up. A small sample—say 100 grs. of glue, 150 grs. water—can be dissolved up and when in good solution 1 gr. of bi-chromate of potash or chrome alum substance can be added. Results should be carefully watched.

Should the glue go stringy too much of the chemical has been added and process will have to be repeated, using about one-half as much of the chemical to the regular amount of glue and water until a working formula has been established. I do not know of an absolutely waterproof glue made from animal glue that can be bought on the open market. Good results can be obtained by following out the above directions.

Some varnishes may be made sticky enough to hold wood together. Shellac in alcohol also may do it. Many formulas are found published for making waterproof glues, but they should be tried very carefully before being adopted as a true working proposition.

Percentage of Loss in Air Service

Contrary to the popular opinion, says a statement issued by the War Department, the air service of the Army is not the most dangerous. Captain Aubrey Lippincott, U. S. A., in charge of the personnel of the Signal Corps of the Army, says that the records of our Allies put air service fourth in the percentage of losses. The heaviest losses have been in the Medical Corps, next in Infantry, and third Artillery.

Death of Captain DeLaage

According to a Paris dispatch Captain DeLaage, commanding the American escadrille, was killed while flying near Ham, on the Somme front, in a special machine of the climbing type to attack a German.

Lieut. Col. William Mitchell, an American officer, and representatives of the corps and the American embassy attended the funeral.

A French Aviator's Message to America*

By Lieut. de la Grange

Of the French Commission

At this time, when you are preparing to make the greatest effort in aviation that has been made so far by any country, I would like to tell you why I have such confidence in your undertaking, and what great results one has a right to expect from it.

I know that in a country where aviation, as a military arm, has been ignored until now, it seems inconceivable to certain people that such formidable amounts of money have been asked to carry out the program which your committee has mapped out. I am not surprised that some people have honestly asked themselves if it would not be a mistake to expend so great a part of the industrial and military effort of the United States in aviation.

It is you, gentlemen, because you have a better knowledge of the situation than anyone else, who will have to say again and again, that no sacrifice will be in vain to secure the mastery of the air. You, yourselves, must be absolutely convinced of this, so that you in turn may convince others.

This war has been full of surprises. At first the Germans took the initiative, using methods which were convenient for them and suited their temperament; but during the short period when the Germans were compelled to fall back on the Marne, the war was directed by the Allies. Since then, however, the Germans, aided by their efficient methods—fruit of long years' labor—have given the war a defensive character. This is the reason why none of our offensive moves so far have been completely successful. Whenever the armies have met in the open, the Allies have had the upper hand, but they have been unable to pursue the advantage, for sooner or later they were checked by that formidable array of all the arms that modern science has invented. Fortunately there are two domains where, if they truly wish, the Allies can reign supreme: the sea and the air.

I will not talk of the naval campaign. That is not my specialty. But in all which concerns aerial warfare I am thoroughly convinced that we must work with supreme energy, and that there the United States can play a great part. In this direction the enemy can do nothing to bar our way.

The enemy may prefer to fight on land with mine and shell, burrowing themselves into the ground, rather than struggle in the open, in the good French way, facing each other. In the air, at least, they must fight man to man, or acknowledge themselves defeated. The air belongs to everyone, or rather to him who knows how to conquer it with a high hand. There, traps do not exist, nor hidden machine guns, nor other obstacles that warp the conditions of the fight. In the sky there are two men, armed alike, who fight like knights of old in their tournaments. It is the bravest and the quickest who wins, and when he has won, the sky, German as well as French, is his.

You understand the beauty of this struggle, in which all is beautiful, even death. Is there any death more beautiful and clean than that of the aviator, struck down in loyal combat, by a bullet? The French love the risk and the danger, they play the game well, but they hate treachery. It is the same with the American. Yes, when our pilots and their brave English comrades appeal to young America, they know that it is filled with courage and high ideals.

Those who give themselves up to the skies of France in 1918 will take part in a great battle, the prize of which will be the supremacy of the air. If we lose, our military operations will be hindered, and our towns, whose sons have given their lives in defending them, will be a constant prey to the destruction wrought by German aviators. If we win, the field will be cleared for our enterprises. Our armies will regain complete liberty of movement, while the German army will be deprived of its most precious source of information. Moreover, it will give us a chance to push the war into enemy territory. Our bombing squadrons will harass reserve forces continually, and attack all the important strategic points behind the lines, and the Germans will no longer be able to feel secure anywhere. America will come to know the difficulties of this plan, but they will not hinder her. The work has already begun, and before long you will teach the enemy the valor of your pilots and the excellence of your machinery. Germany does not believe that you will ever be a redoubtable enemy. Just as she was mistaken in 1914 when she talked of the "little English army," so now she is miscalculating the "little American aviation." Our allies, the English, showed them in good style that they were much mistaken. You Americans will do the same. Some years ago the Kaiser proclaimed that the future of Germany was on the sea. America can proclaim now that her future in this war is in the air.

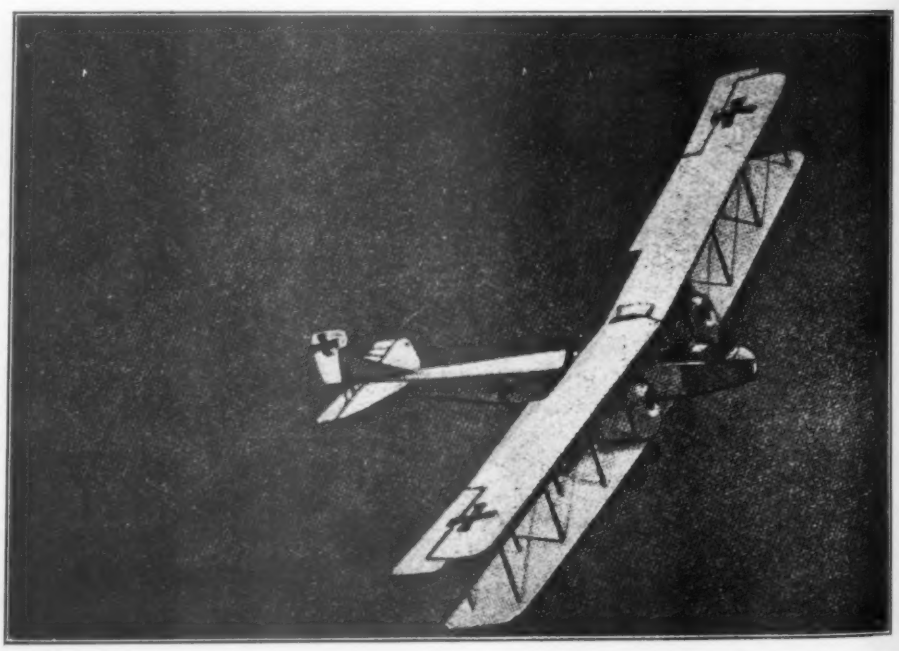
Classes and Types of Machines Required

Three different types of machines are used in modern warfare—the fighting, the reconnaisance, and the bombing machines. All of these except the fighting machines must be able to carry our light bombing; that is to say, they must be able to transport 200 lb. of bombs. When we say bombing machines, we mean a machine which is designed only for bombing purposes. It must have a carrying capacity of about two tons.

A fighting machine must have the following qualities: speed, handiness, great climbing ability, and high ceiling. The constructor must bear this in mind, and never sacrifice one of these qualities for the benefit of one of the others. If a machine was so built that it would be excellent for fighting at low altitudes, but would be no good above 12,000 feet, such a machine could not be adopted by the army, because the conditions of modern warfare are such that the machines are constantly obliged to seek high altitudes. It is not rare nowadays to meet German airplanes at a height above 18,000 feet. When it comes to fighting, the quality the pilot most prizes in his machine is handiness, of which speed is one factor. Therefore, you must not forget that you cannot value exactly the worth of a machine before it has been tested thoroughly by old and experienced pilots.

Our machines have always been, and are are still, more handy than the German ones. This is one of the reasons why our fighters have been so successful.

The reconnaissance machines ought to



AMONG THE MACHINES RECENTLY BROUGHT DOWN BY THE INVINCIBLE CAPT. GEORGES GUYNEMER WAS A TWIN-ENGINED GOTHA THREE-SEATER, DESCRIBED BY M. JEAN LAGORGETTE IN "L'AÉROPHILE," AND ILLUSTRATED ABOVE. THE LENGTH OF THE MACHINE IS 40 FT. 10 INS., AND THE SPAN OF THE UPPER WING, WHICH IS SLIGHTLY GREATER THAN THAT OF THE LOWER, IS 78 FT. THE WINGS ARE SWEPT BACK AND HAVE A DIHEDRAL. IT WILL BE NOTED FROM THE PICTURE THAT THE AILERONS ARE BALANCED, ALTHOUGH THE ELEVATOR IS NOT. THE POWER PLANT CONSISTS OF TWO 260 H.P. MERCEDES ENGINES DRIVING PROPELLERS AT THE REAR, AND THE CHASSIS IS MADE UP OF ONE PAIR OF WHEELS UNDER EACH ENGINE. TWO MACHINE GUNS, POINTING TO THE FRONT AND TO THE REAR, ARE MOUNTED, IN ADDITION TO BOMBING APPARATUS.

* Address delivered to the S. A. E. at Washington, June 26.

have the same qualities as the fighting machines, but naturally they cannot have them to the same degree, because they have to carry more weight, and therefore they are bulkier. They have to carry an observer, extra fuel, a wireless apparatus, and occasionally bombs. The landing speed of these planes is a factor that must be taken into consideration for two reasons: the first is that as the best pilots will be used to fly the fast fighters, those that are left to fly the reconnaissance machines are often less skillful. The second reason is that night flying is becoming more and more necessary. The danger of landing at night must not, however, be exaggerated. It is merely a question of training.

The number of reconnaissance machines needed by an army depends upon the numerical strength of this army. It has proved useful to have four reconnaissance squadrons of fifteen machines each for every army corps of two divisions. But the number of both fighting and bombing machines is limited only by the possibilities of production, and by that of training a sufficient number of pilots. From a military point of view, the reconnaissance machines are the most useful. However, these airplanes cannot carry out their work without the help of the fighting machines. The bombing machines are much less useful unless they operate in very large numbers, and in a sky where enemy machines are no more allowed to fly.

In theory, each airplane should be able to defend itself.

It must not be forgotten that speed and climbing ability will often be as good weapons as a machine gun. There is a saying in the cavalry that runs as follows: "The horse is the best weapon of a cavalryman." The aviator can say the same of his machine, therefore the pilot must have confidence in his machine, and the constructor must give the airplane a high factor of safety. As a rule, there is actually no danger in flying, because of defects in the machine. The great danger comes from the high speed at which one must fly, which makes the slightest mistake made by a pilot when he is near the ground a fatal one.

All modern airplanes are of the tractor type. The reason is that in theory each airplane should defend itself. The pusher type, if attacked from the rear, could not defend itself.

Tests

Before an engine of a new model is accepted by the French army it undergoes a test of fifty hours. During five days it runs twice a day for five hours, during a half-hour of this time at full power, and for four hours and a half at nine-tenths of that power. For example, an engine which is said to produce 200 h.p. will be tested during five days twice a day for five hours, and will run for the first half-hour each time at 200 h.p., and for the following four hours and one-half, at 180 h.p., this last to compensate the tenuity factor. An engine loses one-tenth of its power at 6000 ft., because of the diminution of compression in the cylinders. Owing to the lessened pressure of the air, a smaller amount of gas is admitted in the cylinder at each stroke. When a new engine is finished it is tested for three hours on a testing block, then taken apart, examined, reassembled and tested for twenty minutes. The airplane when complete is accepted only after having been tested, and having fulfilled all the conditions required in the contract. The climbing speed is one of the most important factors.

Difficulties of Production

The plane itself can be easily built; the same cannot be said of the engine. The airplane engine is very different from that of the automobile. The constructor is limited by the weight, and has to solve the difficult problem of designing an engine weighing only about two lb. per horse-power, which will be reliable and not cumbersome.

The automobile engine does not work constantly at its maximum power, as the airplane engine does. Fortunately, at high altitudes the engine, as it gives less horsepower, is under less strain. It would be interesting to test the engines artificially, under different air pressures, so reproducing the conditions under which they will be used.

The constructors will have to use remarkably good material. The steel must have high resisting force, and yet not be brittle.

The crank shaft and the roller bearings must be as light as possible to avoid vibration, and allow the engine to turn at a high number of revolutions. Aluminum pistons have given very good results, because they are lighter, are excellent heat conductors, and therefore preignition is less likely. When alloyed with other metal, aluminum can be used for many parts of the engine.

Hardening is very important. It must penetrate progressively into the metal it is covering.

Lately, most of the cylinders have been made of steel, but it is possible that cast iron may again come into use if we must build engines turning at 2000 or even 2500 r.p.m. The steel cylinder would not allow this, and though they are lighter the increased weight of the cast iron will be more than made up by the greater power of the engine.

Examining the different types of engines, we find that actually the qualities of rotary engines are balanced by those of the fixed engines. Each has its advantages, but it is probable that the fixed engine will soon be the only one which will be satisfactory, the weight of the fixed type, which was its great drawback, having been greatly diminished lately. It will probably be even more so in the future. Its horsepower can grow without its size increasing as much as that of the rotary engine. It does not seem possible to have a rotary engine which can turn faster than it does now, therefore, to increase its horsepower it would be necessary to increase so greatly the size of its cylinders that it would be impracticable. On the contrary, the fixed engine will certainly be brought up to 2,000 or 2,500 r.p.m.

Aviators

It is almost impossible to say beforehand whether a man can become a good aviator. Some of the very best French pilots were in such bad physical condition that they had been rejected by the army. In spite of this, as it is necessary to train a great number of pilots in the shortest possible time, men in the best physical condition must be chosen. If after a short period of training they prove slow at learning, though not absolutely unfit, they must be rejected without hesitation. No time should be wasted over slow pupils.

An aviator must always do individual work, consequently, he must have a great sense of duty. He must also be more intelligent and better educated than the average infantry man. The more mechanical and engineering knowledge the pilots possess the better it is. This they must be given during their training, so that when they are at the front, they will be able to oversee the work of the mechanics and to test their engines themselves.

A good pilot is always busy with his machine when he is not flying. He must also be a good shot and practice daily. The importance of this is understood when we know that Guynemer, the "star" French pilot (who has brought down 43 German machines) is now so skillful that he often brings down the machine he is attacking with a single shot.

Mechanics

The life of the pilot often is in the hands of his mechanic. The latter must be competent and careful. Each pilot in a squadron has two mechanics to take care of his machine, and one of them is an expert and does all the fine mechanical work while the other only cleans the engine, oils it and fills the tanks. The mechanics, as they always work for the same pilot, are proud of him and take the greatest care to keep his machine always in good order.

It is impossible to train a good mechanic rapidly, and therefore, they must be chosen among the workmen who have a thorough knowledge of automobile engines. No important repairs are made at the squadron, so it is not necessary to have good adjusters there. The place for these is in the repair shops where the engines are sent when there are important repairs to be made.

From these scattered remarks, I hope that you can see what a powerful aid in aviation the United States can be to the Allies. Your men will make good pilots, your mechanics can be used at the front or in factories; and since your country is so great industrially, if the program which the American authorities have outlined is carried through, you ought to be one of the main factors in determining the strength of Allied aviation, which depends so largely on industrial excellence.

A Standard Engine for American Aircraft

The National Advisory Committee for Aeronautics authorizes the following:

The Aircraft Production Board realizing the need for the development of a standard engine in various sizes has succeeded in obtaining the cooperation of two of the foremost engine designers in the country, Messrs. Jesse G. Vincent, of the Packard Motor Car Co., and Elbert J. Hall, of the Hall-Scott Motor Car Co. The fundamental idea of the engine is a unit cylinder by means of combinations of which any desired power may be obtained. It is proposed at first to build engines in four sizes of 4, 6, 8 and 12 cylinders, the corresponding horsepowers being approximately 100, 200, 300 and 400.

The cooperation obtained in the design of this engine has shown the feeling of patriotism which is common throughout the country. Requests were sent out to the foremost engine draftsmen with the various automobile and airplane companies throughout the country, and the volunteers worked night and day without compensation of any kind whatever.

The facilities of the Bureau of Standards for the assembly of this engine have been placed at the disposal of the Aircraft Production Board, as well as the accumulated knowledge of the bureau and its staff of the various metallurgical processes necessary for the successful completion of the engine.

The development of this engine will in no wise interfere with or retard the development of private manufacturers, but if anything should stimulate them to further effort.

Spark Gaps in Series with Spark Plugs*

By Morris R. Machol

Of the Speco Manufacturing Corp.

The history of the spark gap goes back to about 1900. Racing drivers discovered that when spark plugs went bad by forming an auxiliary gap outside of spark plugs could make these spark plugs work. The method was to tie a piece of wood to the spark plug, tie the wire to the wood and thus form a gap. The spark plug worked all right, but the spark in the open air brought with it many disadvantages. There was the very great loss of electricity which was discharged into the air; the high resistance of the air, resulting in a very heavy amperage draw from the system, and the result was that the batteries ran down very quickly and coils were very frequently punctured, due to high amperage, and because of the increased resistance of the air gap, also a higher voltage. Spark gaps of this nature appeared on the market even within recent years.

The usual form is a red fiber body and two brass points for electrodes. Of course, high amperage and high voltage not only drain the battery and damage the coil, coil points and magneto, but they also result in rapidly burning off the electrode points of the spark gap, so that the device very soon burns itself into an inefficient condition. It was, however, continually open to the objection that it was not at all fireproof and that the exposed spark was always liable to cause damage from fire.

The next step in the process was the development of a glass enclosed device. A glass cylinder was made, to the end of which was attached metal caps, carrying the electrode points. This device still has the disadvantage of discharging all of the current across the air gap with consequent high resistance, high amperage and heat, and although this design would seem to make the device fireproof, it had the disadvantage of confining the air around the points, the result being that the discharge very soon ionized or nitrogenized the air inside the device, which practically short-circuited the device itself, and except when starting the motor it very materially reduced the efficiency of the device. The effect was that ionizing the atmosphere inside the device still further increased the heat, with the result that the points burned off rapidly and the glass cracked and broke.

The next improvement was to introduce a dielectric block which would mechanically hold the two caps together. The effect of this was that when the heat broke the glass, the device did not fall apart. The next improvement was to use mica instead of glass, and this did overcome the disadvantage of breaking the glass, which did not, however, make the device entirely fireproof, and neither did it overcome the evil effects of excessive amperage, excessive heat, continual necessity for readjusting or renewing the spark-gap electrode points.

There were some spark gaps introduced in the market in which the entire gap was surrounded by a cylinder of metal. This device is fireproof, but it does not give the advantage of a visible spark, and it does not prevent the electrode points from corroding or burning off, due to the high amperage or intense heat, resulting from discharging all of the current across the air gap. The ionizing of the atmosphere inside of this device also materially assists the corrosion of the electrode points.

The only practical spark gap is one that will be fireproof and ventilated, and one in which there is no possible chance for the electrode points to corrode. Such a device must first have a distance or center block of fiber or bakelite or some other substance of extremely high dielectric resistance. This center block holds firmly in place the terminals which contain the spark-gap electrode point. Through holes drilled in the center block the spark becomes visible. The device has two caps, one at each end, which are made of fiber and impregnated with carbon so that they become electrical conductors. Between the caps and surrounding the center block is a screen which has the official mesh of the Davy miner lamp. This screen is made of copper, oxidized black so that the spark across the gap is easily visible. The Davy gauze makes the device absolutely fireproof even against as inflammable a substance as marsh gas. The device now becomes a true electrical condenser.

One type of condenser consists of parallel strata of tinfoil, separated by layers of mica, where the conductor is the tinfoil and the dielectric is the mica. In the device I have described the copper gauze is the conductor, conducting the electricity in parallel lines, and the air contained inside the gauze is the dielectric, so that the device becomes a true electrical conductor, increasing the voltage and decreasing the amperage. Practically, in this device, only a portion of the electricity jumps the air gap, which of course keeps the amperage very low. The device is amply ventilated through the Davy gauze, which prevents even a low amperage from developing any heat at the electrode points.

The electrode points in this device are made of platinum substitute, as platinum is too expensive and difficult to get. The platinum substitute is composed largely of nickel and will do absolutely the same work. This spark gap has a peculiar effect on electric current. In the case of battery and coil, the direct current from the battery becomes a pulsating current when it leaves the coil.

In the case of a magneto we get straight alternating current electricity. In either event the current in jumping the gap changes its nature, becomes an oscillating current of very high frequency and takes on some of the properties of static electricity, in that it will seek its opposite pole. The result is that even when a spark plug is short-circuited with carbon, graphite or oil, this current will ignore the short and jump the gap at the spark plug points. The use of this spark device, therefore, first absolutely insures against possibility of spark plug trouble. Furthermore, the spark plug cannot fail to fire. Broken porcelain, carbon, oil and even water will not prevent the plug from firing. The next advantage is the visibility of the spark. The device becomes practically a window into the cylinder. If the gaps show a spark and there is any trouble, it stands to reason that it must be carbureter trouble. If but one gap fails to show a spark, then the trouble must lie in the distributor, and following that particular lead to the distributor will locate the trouble at once. If the motor will not start and none of the gaps show a spark, the trouble must be with the magneto. The visible spark is a wonderful aid in timing a motor. A finger held over the pet-cock will indicate when that cylinder has compression, and the spark gap will then tell which terminal is giving a spark at that time, whereupon it becomes a simple matter to connect up that particular terminal with the cylinder compression.

The spark that is produced at the point of the spark plug when the spark gap is in series with the spark plug is a fatter, stronger, better spark than would otherwise be produced. This gives a little more power and quicker ignition. It is self-evident that the better spark makes easier starting. You may have had the experience of putting a new magneto on a car and having to cut down the adjustment of the carbureter, because with the better spark it was not necessary to have so rich a mixture. The spark produced with the spark gap permits of the use of a leaner mixture, which not only saves gasoline but also cuts down carbon deposits in the cylinder. This is because carbon comes largely from the partially burned gasoline, resulting from the use of too rich a mixture. Oxygen has a greater affinity for hydrogen than for carbon, and with too rich a mixture the hydrogen is burned out leaving the carbon.

Another advantage is that, with the spark gap, all plugs give the same intense, high-frequency spark, no matter whether they are old or new, good or bad, dirty or clean, broken or whole. The result is an even torque motor, which means less vibration, less pounding of the bearings and less wear and tear.

The fact that the device described is a condenser, means that although the voltage is increased, amperage is reduced, consequently with the lower amperage the spark plug electrode points will not burn out. The lower amperage lengthens the life of the battery. Even in the case of a short-circuited plug where the electrode points are in actual metallic contact, the spark gap becomes a safety gap and prevents the possibility of drawing all the amperage that the system will produce across the magneto or coil points and thus burning out these expensive platinum points.

* Paper delivered at the 10th Annual Convention of the National Gas Engine Association, Chicago, Ill., June 7th, 1917.

The Union Six Cylinder Airplane Engine

Details are now available of the 6 cylinder, vertical, 4 cycle, water cooled engine made by the Union Gas Engine Co., of Oakland, Calif.

This company has been making marine engines since 1885, and in September, 1915, started experimental construction work on an airplane engine. The result of their work was recently tested by the Government, as shown by the following information furnished by the manufacturers.

Under direct supervision of Army and Navy inspectors (C. G. Williams, Senior Inspector in Charge) an endurance run of forty-eight hours was made, beginning May 10 and lasting until May 31, consisting of eight consecutive, full throttle, six-hour runs, followed by a tilting test. The main test was carried out on a cradletype dynamometer, with propeller attached directly to the crankshaft, and all conditions made, as far as possible, to simulate those of actual flying. The installation was further made to conform in every particular to the requirements of Army Specification No. 1002.

The test was performed at the Union Gas Engine Co's factory, Oakland, Calif., and consisted of 48 hours running made up of eight separate runs of six hours each on consecutive days from May 10 to May 18 inclusive.

The engine was mounted on torque cradle frame. This test stand is of a similar design to that used at the Navy Yard, Washington, D. C. The rated output of 120 hp. at 1350 r.p.m. was obtained with a pusher propeller.

The necessary calibrations were made of the thermometer and pressure gauges to determine their accuracy, also the brake arm radius was checked, and the tare weight of the torque stand determined.

The main test each day was started after a preliminary warm up of five minutes. Readings of all instruments were taken every thirty minutes and the hourly average entered on the leg sheet.

The r.p.m. were computed from the readings of a positive continuous counter, stepped down ten times, direct connected to the crank shaft. The torque was obtained from the readings of the spring balance scale. The B.H.P. was computed by the standard S.A.E. formula, using the previous noted readings.

The initial level of the gasoline in the feed tank was marked on the gauge glass. Every half hour the fuel level was brought to this mark, the quantity necessary to accomplish this being weighed and entered on the leg sheet. The summation of these represent the total consumption for the run.

The oil consumption was obtained by weighing in the initial oil and weighing out that which remained in the tank at completion of each test and resulted as shown below.

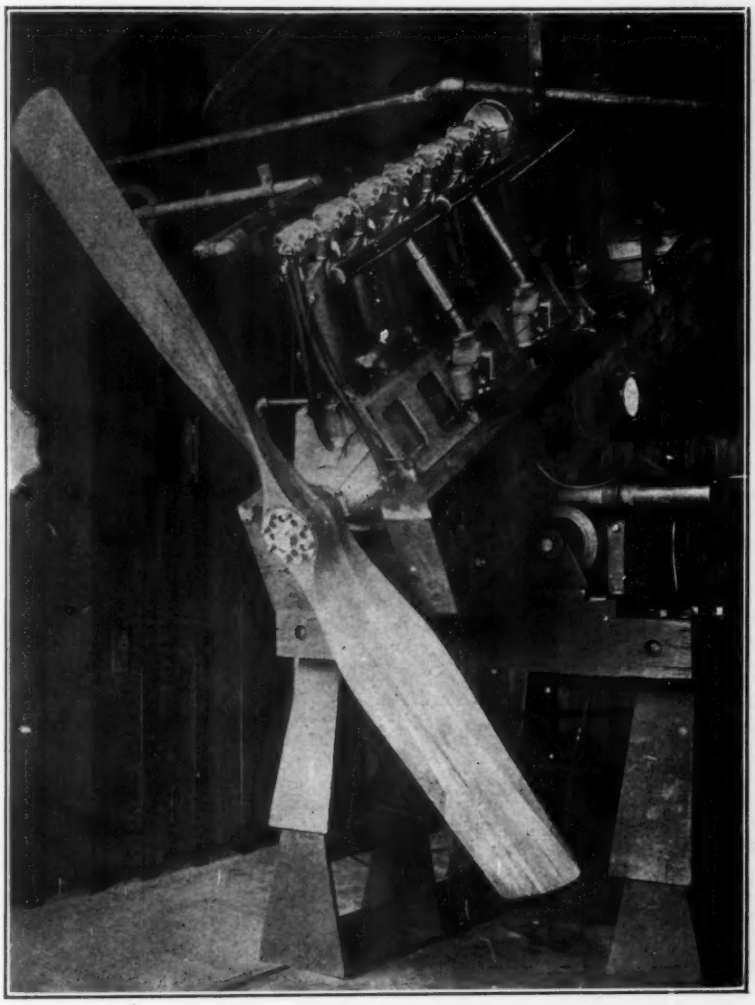
The engine performed a very satisfactory endurance test. Observations throughout the test showed that the vibrations were low, quick acceleration and good carburetion maintained, also the absence of oil leakage was another good feature as well as no evidence of water leakage at any of the joints.

The maximum power developed was 123.5 hp. while the engine averaged 118 hp. on last day, with an overall average of 120. Inspection of parts showed that with increase of piston clearance a higher average could be expected as the friction hp. was excessive, due to drag of two pistons.

On the fourth day's test, Zeroline Special with a gravity of 20 deg. Baumé was used during a portion of the test showing that this engine would perform satisfactorily with lubricating oil varying from 20 to 30 deg. Baumé gravity. The average oil consumption was 0.27 gals. per hour or 0.0124 lb. hp. hour.

The average gasoline consumption was 10.7 gals. per hour or 0.558 lb. hp. hour, while the overall thermal efficiency based on B.H.P. was 0.222.

The engine demonstrated that its design and construction was such that it would stand endurance test of a much longer duration as when the run was stopped the engine was functioning very satisfactorily.



TILTING TEST—RUNNING AT FULL POWER, INCLINED 20 DEG. UP—RUNNING AT 25 PER CENT. POWER, INCLINED 30 DEG. DOWN

Summary of Inspection

The inspection of the engine after the 48 hour endurance test showed that the fundamental design to be such that satisfactory service would be given by this power plant. The quality of the workmanship throughout was of a very high order, and also that the very best of material had been used throughout the engine.

The above is substantiated by the following points, further details of same being included in inspection report proper.

Vibration

All nuts outside of those on the cylinder yoke hold downs were not cottered on. These were not tightened during the test, and all of these were tight as much at the end as in the beginning of the test.

The engine parts were well lubricated and in good shape and there was little evidence of undue wear. Although a high oil pressure of 90 to 100 lb. sq. in. was carried throughout the run, no serious oil leaks developed, and that from the cam shaft around the rocker arms was practically negligible.

Quality of Workmanship

The crank shaft was set up fairly stiff and at the end of the test this was checked up. Due to static friction, the crank shaft could not be revolved by applying pull on crank pin. Once, however, the shaft rotation was started by applying pull at a greater leverage it could be kept revolving easily by mechanic, exerting force on pins. This speaks well for workmanship.

General Specifications

Type

Vertical six separate cylinders, water-cooled, overhead valves.

Horse-Power

Rated: 120 at 1,350 r.p.m.
Maximum r.p.m., 1,420.
Normal r.p.m., 1,350.
Minimum r.p.m., not given.

Bore and Stroke

4¾ by 6½ in.

Gas Consumption

10.5 gallons hour, 58 deg. Baumé at 60 deg. Fahr.

Weights

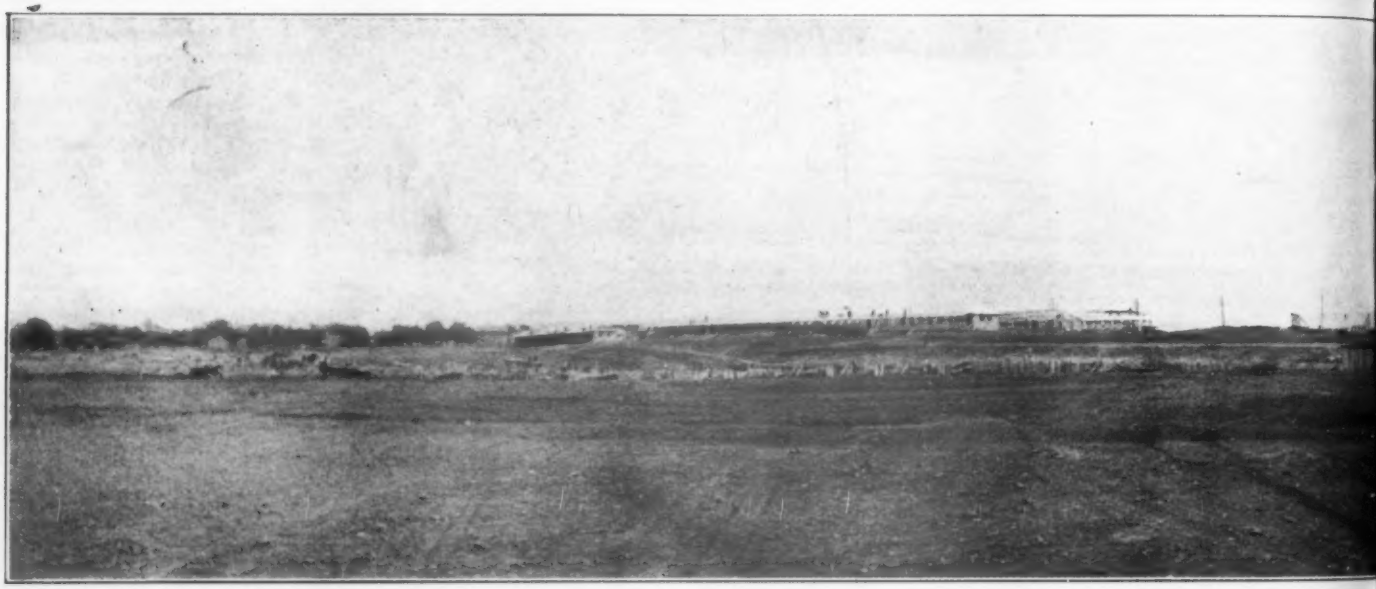
Motor-starting crank, exhaust pipes and propeller flange off	485 lb.
Crank shaft	63 lb.
Upper crank case	116 lb.

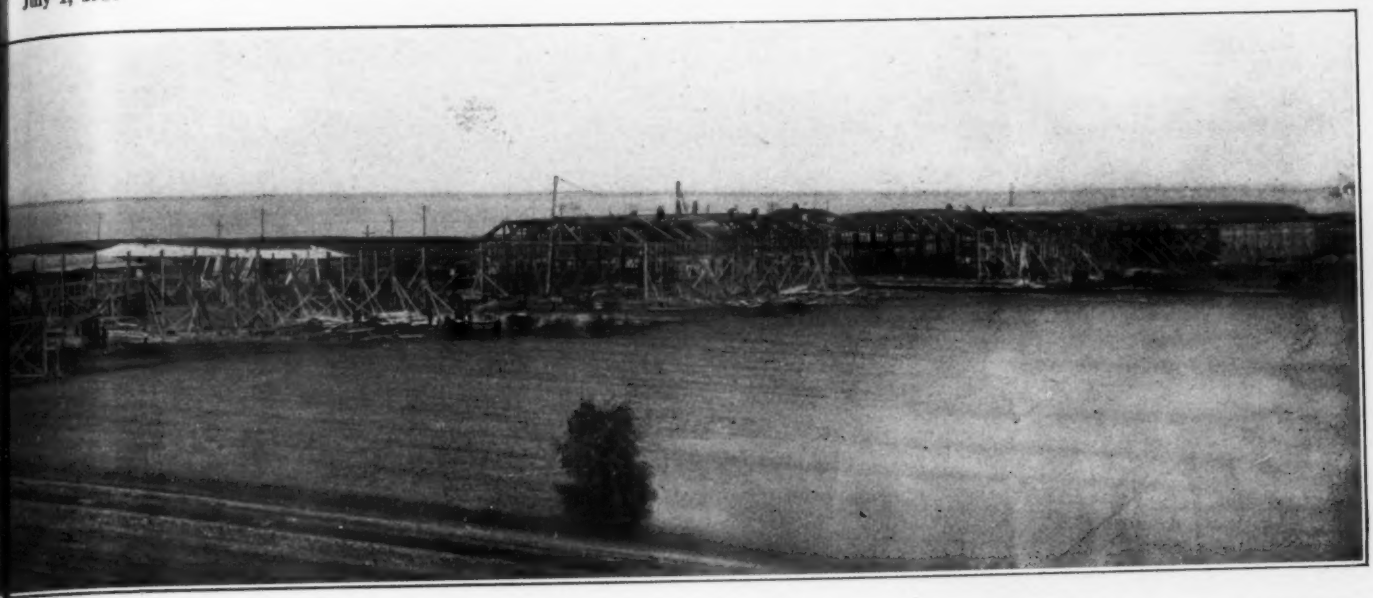
Oil Consumption

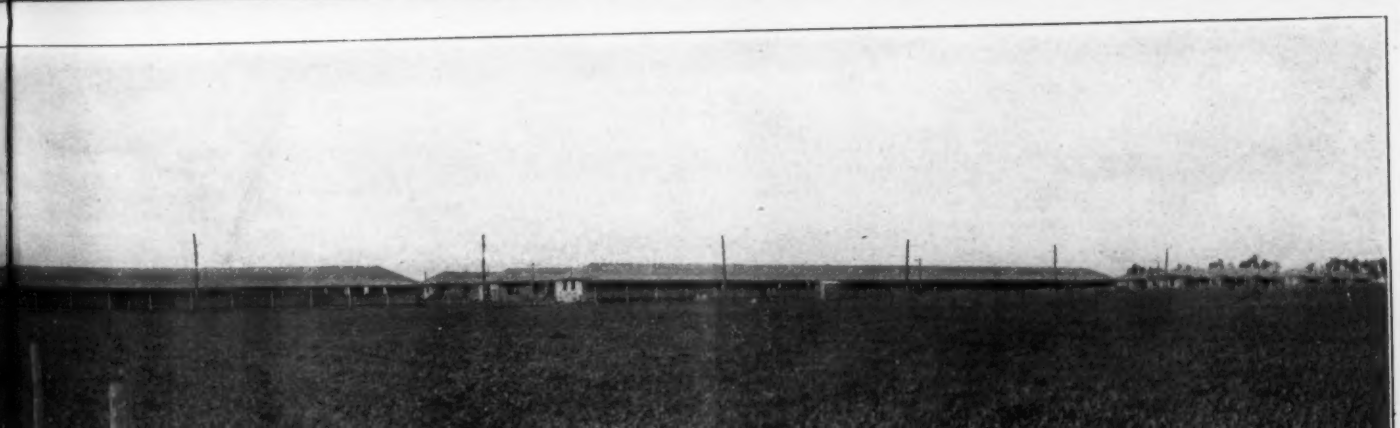
0.30 gallons per hour.
0.018 lb. h.p. hour.
20 deg. Baumé at 60 deg. Fahr., Wolfhead Oil used.
20 deg. Baumé at 60 deg. Fahr., Standard Special Heavy Duty used.

Installation

Overall length	65-⅛ in.
Overall width	17 in.
Overall depth	40-¾ in.
Width at bed	17 in.
Height from bed	28-¼ in.
Depth from bed	12-¼ in.







THREE OF OUR NEW FLYING FIELDS

The above pictures show the progress that is being made at top picture shows Selfridge Field, at Mt. Clemens, Mich., which this country, and who was the first army officer to lose his li large extent of Wilbur Wright Field, near Dayton, O. It is app of having within its borders the field where the Wright bro shown in the bottom picture. It is named in memory of Octave of aeronautics in the early days.

Katherine Stinson Flies for Red Cross

Pilots Curtiss Machine from Buffalo to Washington in Remarkable Flight

Flying a Curtiss J.N.-4 military tractor, Katherine Stinson made a remarkable flight June 24-25, from Buffalo to Washington, a distance of 670 miles, in a total flying time of eleven hours and a few minutes. She made the flight in the interest of the Red Cross campaign for war funds, and dropped appeals for subscriptions to the fund over cities she passed, and carried checks from Buffalo, Albany, New York and Philadelphia for delivery to the headquarters of the Red Cross in Washington.

BEFORE THE MACHINE AT THE CURTISS PLANT IN BUFFALO JUST PRIOR TO STARTING ON HER FLIGHT

Miss Stinson arrived in Buffalo two days before her flight, to purchase a Curtiss machine. As it was impossible to deliver a machine before next month, permission was secured to use one of the Government machines, and Miss Stinson, with fifteen minutes in the air in the machine to try it out, started on her trip at noon, reaching Albany at 6 o'clock, landing on Van Rensselaer Island, made famous by Glenn Curtiss on his flight from Albany to New York. She left Albany at 10 o'clock the next morning, and landed on Governor's Island at noon, where she was met by a committee from the New York Red Cross, newspaper men and Army officers. Resuming her flight at 2 o'clock she landed in Fairmount Park, Philadelphia, at 3.20 o'clock, where similar committees met her. Leaving Philadelphia at 5.30 o'clock, she reached Washington shortly after 7 o'clock, and after encircling the Washington monument, came down on a huge white cross on the Polo Grounds, south of the monument at 7.45 o'clock.

(C) American Press Ass'n, N. Y.

BEING GREETED BY MAJOR HOWARD, U.S.A., AFTER LANDING ON GOVERNOR'S ISLAND, N. Y.

Here a huge crowd awaited her, which heartily cheered her for her pluck and skill, and escorted by Red Cross officials she proceeded to the Treasury Building, where Secretary McAdoo was awaiting her. On the steps of the building she delivered to the secretary checks for the fund, letters and credentials, and Mr. McAdoo, in accepting these, said:

"I congratulate you upon your wonderful achievement. You have shown that you possess the same spirit that is characteristic of the true Red Cross worker. You dare to face danger and even the possibility of death itself in the performance of your duty. You have done your duty and done it well."

Miss Stinson made this flight entirely upon her own initiative, and at her own expense, as an unselfish contribution to the cause of the Red Cross, and deserves unlimited credit for her courage, skill and nerve. She took an entirely unfamiliar machine off the Curtiss factory floor—one which had never been in the air—and after trying it out under the eye of instructor Roland Rohlfs for a quarter of an hour, piloted it alone for 670 miles.

The flight also demonstrates in a striking manner the possibilities of modern airplanes. That a young and frail girl should be able to make such a flight, without trouble or delay of any kind, speaks volumes, not only for the makers of this machine, but for the advancement of the science in general. It shows that without any special preparation, a young girl can step into an airplane, of a type she has never handled before, and make a successful flight of nearly seven hundred miles, without difficulty.

It is interesting to know that while Miss Stinson had a map of the country between Buffalo and Albany, she had no map whatever, covering the stretch from Albany to New York, and simply followed the lines of the New York Central Railway. She said, when asked, that she did not follow the Hudson River "because she was afraid of the water." For the rest of the flight, she used an ordinary railroad map, published in the folder of the Pennsylvania Railroad.

(C) Underwood and Underwood.

DELIVERING RED CROSS CHECKS TO SECRETARY MCADOO ON THE STEPS OF THE TREASURY DEPARTMENT AT WASHINGTON

Orville Wright Approves Aerial Program

When Orville and Wilbur Wright built and flew the first man-carrying flying machine they believed they were making wars impossible. Now, with the greatest war in history at a deadlock because of the equality of aerial equipment, a great increase in the allied aerial forces is the one way to end it, Orville Wright asserts. In indorsing the program of the aircraft production board, Mr. Wright declares that "if the allies' armies are equipped with such a number of airplanes as to keep the enemy planes entirely back of the line, so that they are unable to direct gunfire or to observe the movement of the allied troops it will be possible to end the war."

"When my brother and I built and flew the first man-carrying machine," said Mr. Wright, "we thought that we were introducing into the world an invention which would make further wars practically impossible. Nevertheless, the world finds itself in the greatest war in history. Neither side has been able to win on account of the part the airplane has played. Both sides know exactly what the other is doing. The two sides are apparently nearly equal in aerial equipment, and unless present conditions can be changed the war will continue for years.

Must Blind the Enemy

"However, if the allies' armies are equipped with such a number of airplanes as to keep the enemy planes entirely back of the line, so that they are unable to direct gunfire or to observe the movement of the allied troops—in other words, if the enemy's eyes can be put out—it will be possible to end the war. This is not taking into account what might be done by bombing German sources of munition supplies, such as Essen, which is only about 150 miles behind the fighting lines. But to end the war quickly and cheaply, the supremacy in the air must be so complete as to entirely blind the enemy.

"The program laid down by the aircraft production board, if carried out, will obtain this result. The business organization and manufacturing equipment of our country offer the facilities for carrying out this program, and I believe that by no other method can the war be ended with so little loss of life and property."

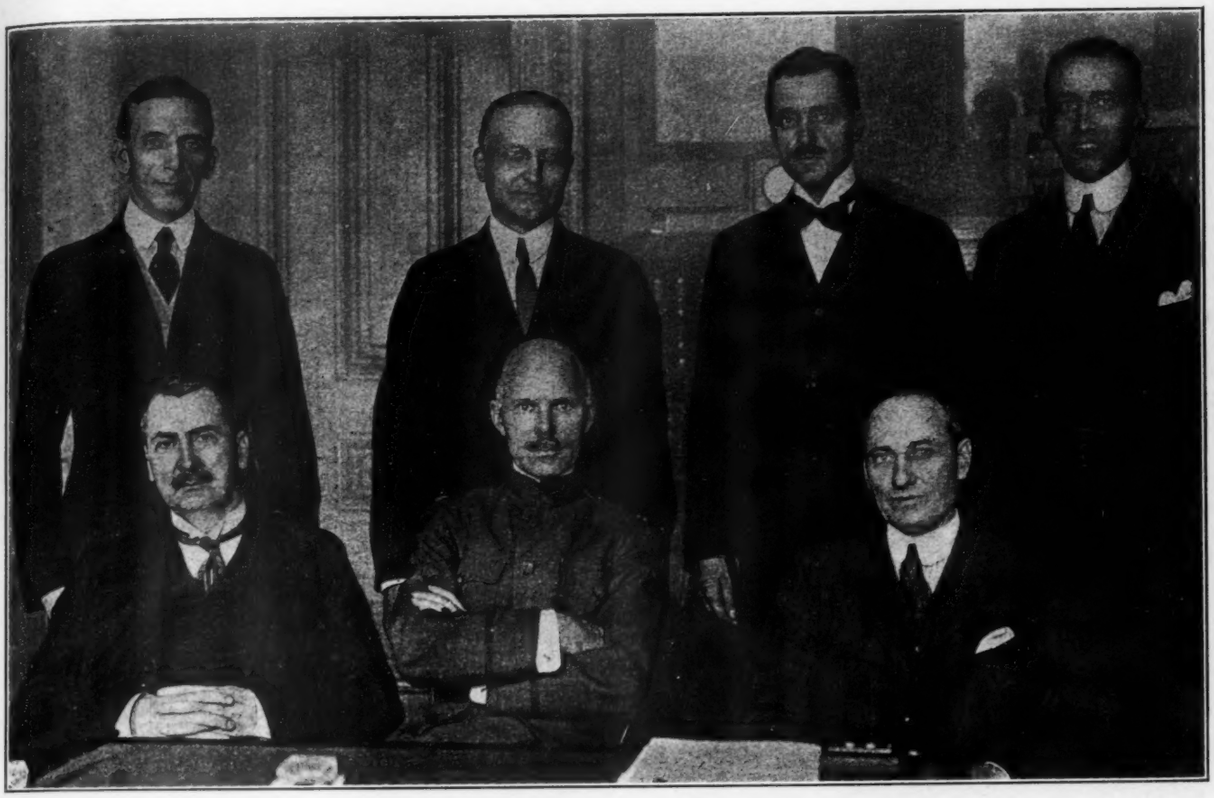
Death of Tom W. Benoist

Tom W. Benoist, of the Benoist Aeroplane Company, Sandusky, Ohio, came to his death accidentally June 14, while a passenger on a trolley car, being struck on the head by some object near the track.

Mr. Benoist was well known in American aeronautics, both as a flier and constructor, and his work in the building of large passenger carrying seaplanes has been considered as an important contribution to the science. Last summer he successfully maintained a daily passenger carrying service between Sandusky and Put-In-Bay, and according to advices received from him recently was constructing a seaplane capable of carrying twenty passengers.

flying fields, which the Army has under construction. The Lieut. T. Selfridge, who was one of the pioneers of aviation in accident, in October, 1908. The middle picture shows the for the elder of the Wright brothers, and will have the distinction early experimental flying. Chanute Field, near Rantoul, Ill., is did so much to assist in the development of the scientific aspect

SELFRIDGE, WILBUR WRIGHT AND CHANUTE



THE AIRCRAFT PRODUCTION BOARD,

formed to co-ordinate all work in connection with the manufacture of airplanes. Seated, left to right, Rear Admiral David W. Taylor, of the Navy; Brigadier General George O. Squier, Chief Signal Officer, Army; Howard E. Coffin, Chairman of the Board and a member of the Council of National Defense. Standing, left to right, Sidney D. Walden, of Detroit, automobile manufacturer; E. A. Deeds, of Dayton, ignition expert; R. L. Montgomery, a Philadelphia banker, and A. G. Cable, of Chicago, Secretary of the Board.

Curtiss Co. Expanding

Announcement was made yesterday that the Curtiss Aeroplane & Motor Corporation had declared the regular semi-annual dividend of 3½ per cent on its preferred stock, payable July 15 to holders of record July 1. This company has made arrangements to issue 63,000 additional shares of common stock, all of which has been underwritten by bankers. It is to be offered to preferred and common stockholders as of July 1 for subscription at $35 per share to the extent of approximately 30 per cent of their holdings. It was officially stated that the corporation had obtained an order from the Government amounting to $20,000,000 for motors, airplanes and aircraft supplies.

Plans for the expansion of the plant were discussed at a meeting of the board of directors. Mr. Curtiss stated that he was hurrying the designs of a new fighting airplanes to develop a speed of 150 miles an hour.

John N. Willys has been elected a member of the voting trust, succeeding James Imbrie, resigned. It is stated that Mr. Willys will have an active part in the management of the company.

One stockholder expressed the opinion that nearly all the new stock would be taken by stockholders. Both preferred and common stockholders of record July 1 will have the privilege of subscribing to the new common stock at $35 per share. There are 60,000 shares of preferred outstanding, par value $100, and 150,000 shares of common of no par value. New stock will therefore be apportioned in the ratio of 30 per cent of the old shares held.

The British Government has practically completed negotiations for the purchase of 100 flying boats from the Curtiss Aeroplane Company. These boats are to cost $27,500 each, which means an order aggregating $2,750,000. A smaller order for the same sort of machine was recently completed by the company. Deliveries on the new order will be started early this fall, and it is expected the machines will be completed by the end of the year.—*From the Journal of Commerce.*

Wittemann-Lewis Model T-T Tested by Edward Stinson

The Wittemann-Lewis training tractor, Model T-T, powered with a 90 hp. Hall-Scott engine, was severely tested at the Hempstead, L. I. field June 28. The machine was flown by Edward Stinson, brother of the famous girl aviator, Katherine Stinson. Stinson accomplished every variety of stunt flying with the machine. He made eight continuous loops, several tail dives, stalls, and did a 1000 foot vertical dive, and threw an excessive strain on the planes by suddenly straightening out. He also flew upside down for several hundred feet. Rough landings were purposely made to prove the structural qualities of the machine. Stinson's handling of the Model T-T is said to have demonstrated great strength of construction, ease of control, and airworthiness.

Curtiss J.N. Machines Now Used on Battle Front

It is stated that at the present time there are one hundred Curtiss J.N-4 type machines in use on the French front in reconnaissance and artillery spotting work.

OFFICIAL INSIGNIA ADOPTED BY THE AIRCRAFT MANUFACTURERS ASSOCIATION

Regulations for the Prevention of Dope Poisoning

The Aircraft Manufacturers' Association has received the following from the New York State Department of Labor:

"The following recommendations will be embodied in our report of the airplane industry, which has recently been investigated—in which we made a study relative to the prevention of poisoning from material contained in the dope of a volatile nature.

"In airplane factories where dope is used a downward system of ventilation should be furnished; intakes to be located at floor level, which should be situated about six feet apart beneath working areas.

"Drying of wings, ailerons and rudders to be done in a room separate and apart from dope room.

"When the body is doped it should be done in proximity to a downward system of ventilation.

"Each morning and afternoon should be interrupted by a fifteen-minute rest period, men to go into the open air during such times.

"Hot running water, soap and individual towels, also overalls should be provided for all dope workers.

"Lockers shall be provided for all dope workers, which shall be well ventilated.

"No eating shall be permitted in any dope room.

"Not less than one hour shall be allowed as a lunch period to any worker engaged in the process of doping.

"Active medical supervision, as early diagnosis of dope poisoning prevents serious after effects.

"No doping shall be conducted in the open air unless it is done under a shed, so as to prevent rapid evaporation of the poisonous fumes.

"Any workers who complain of dizziness or sleepiness should be immediately removed from the work for forty-eight hours.

"For your information, I desire to say that in the places investigated, we have issued orders relative to providing proper ventilation, installation of hot water, individual towels, and in prohibiting of eating and taking food into workroom. In addition to this instructions have been given to persons in the respective plants, as to how such orders should be carried out. In the erection of plants to be used hereafter, these recommendations should be carefully carried out."

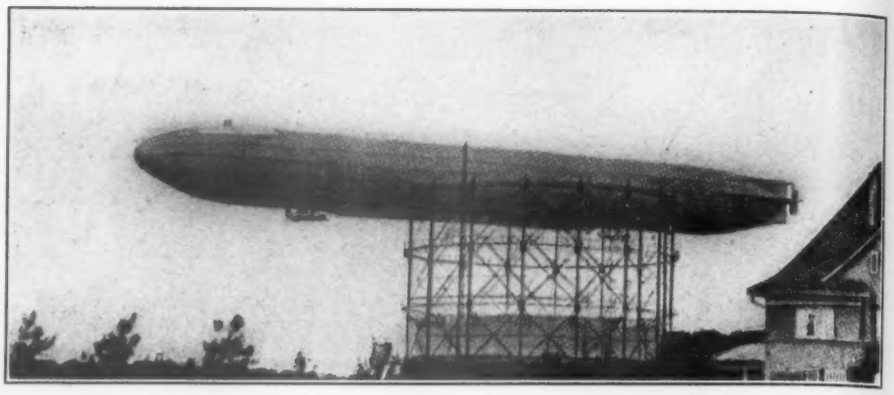
Air Supremacy Discussed

In a discussion of British aero superiority on the western front, Claude Grahame White and Harry Harper bring up several points of interest in recent controversy. One is the standardization of air craft, which has been widely urged, but which Messrs. Grahame White and Harper consider impossible. Another point is speed, which would to some extent be sacrificed to numbers by the writers. What they say is summed up as follows:

"Standardization in war machines is not yet possible; types are changing too rapidly. Therefore, it happens sometimes that, for a certain time, one or other of the antagonists has a fighting machine which is a little better armed or of a slightly greater speed, than the machine of a corresponding type by which it is opposed. Such fluctuations are practically unavoidable. And it is also more or less inevitable that in our air service at the front, and in the enemy's also there should be craft of a more or less obsolete type which we should be glad to supersede if we could, but which cannot be discarded until machines are to hand of a newer and better type.

"The demand for aircraft has, from the beginning of the war, always exceeded the supply—greatly though this his been accelerated; and this is the reason why neither one side nor the other has been able to obtain a final or unquestioned supremacy. We could win such a command if we had a sufficient preponderance in machines and personnel. We must obtain a greater numerical superiority over the enemy, both in machines and pilots. We need not waste precious time in seeking to design or construct any ideal type of airplane. What we must do is to turn out the best machines obtainable today in such quantities that, though some of them may be a mile or two slower, possibly, than certain enemy craft, we shall still have such a clear preponderance in numbers that we shall be able to overwhelm the Germans and defeat them finally and decisively.

"Failing through lack of numbers, any such absolute supremacy, our air service has none the less gained for us, and maintains, such a superiority in offensive action that we operate far more extensively over the enemy's territory than he does over ours; and this means that in reconnaissance from day to day, in raids on enemy communications, and in the aerial direction of artillery fire, the British Flying Corps has rendered, is rendering, and should continue to render, a far greater service to its headquarters than is the case with that of the Germans."



AN INTERESTING PHOTOGRAPH FROM "ESPANA AUTOMOVIL Y AERONAUTICS" SHOWING A ZEPPELIN (1914) ON A REVOLVING PLATFORM JUST BEFORE TAKING FLIGHT

Mortality in U. S. Army Air Service

The National Advisory Committee for Aeronautics submits an official statement of the mortality in the United States Army Air Service by years, from 1908 to April 28, 1917.

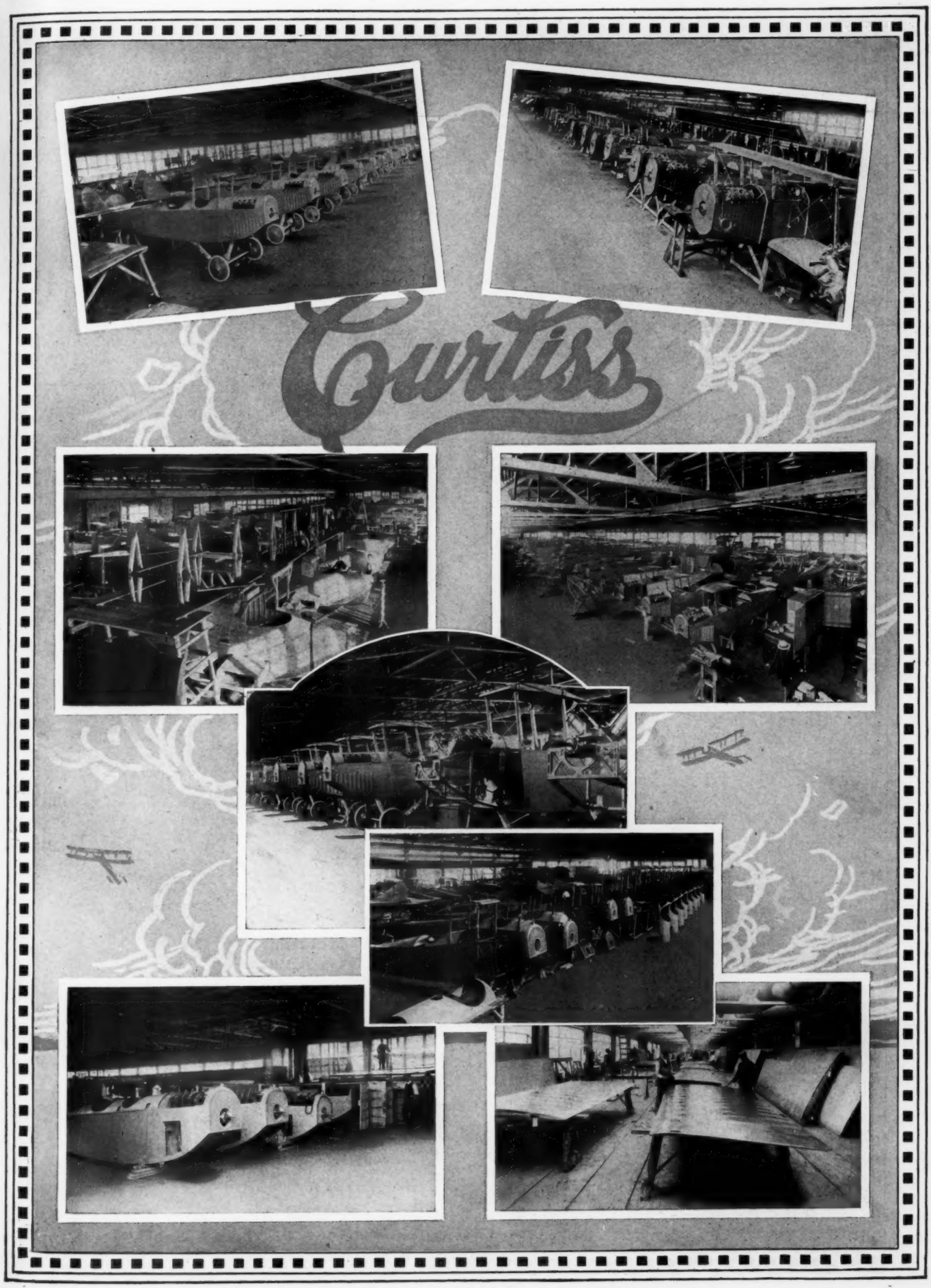
During the years of great experimental activity and development—1911, 1912, and 1913—the mortality rate among aviators steadily increased, and reached the high average of 17.94 per cent in 1913. With the advent of an increased factor of safety, and with larger numbers exposed to risk since 1914, the mortality rate has shown a marked diminution.

STATEMENT OF MORTALITY IN U. S. ARMY AIR SERVICE FROM 1908 TO APRIL 28, 1917.

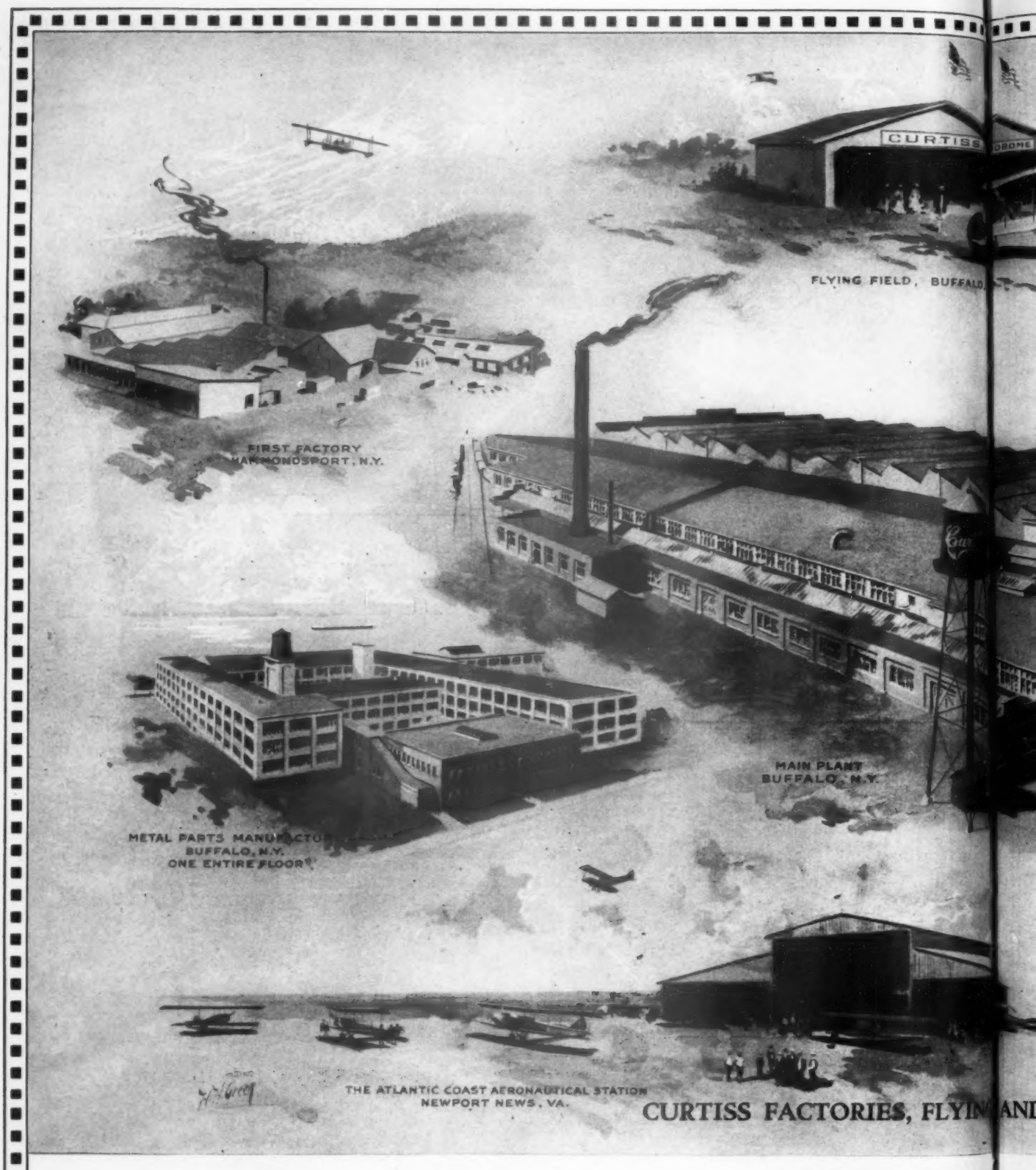
Year.	Number exposed to risk.	Number of flights.	Total hours in air.	Total miles flown.	Casualties.	Mortality. Per cent.
1908...	3	....	....	....	1	33.33
1909...	2	....	....	....	0	00.00
1910...	1	....	....	....	0	00.00
1911...	9	731	129	....	1	11.11
1912...	20	1,498	225	....	3	15.00
1913...	39	3,355	739	39,337	7	17.94
1914...	21	2,680	824	49,440	2	09.52
1915...	45	4,388	1,814	126,980	1	02.22
1916...	96	11,084	5,337	400,200	0	00.00
1917 to Apr. 28.	110	9,306	4,716	353,700	0	00.00

There have been up to April 28, 1917, thirteen accidents, resulting in fifteen fatalities. In these accidents nine of those killed were pilots and six passengers. These figures refer only to those accidents in which officers or enlisted men of the Regular Army were involved. The mortality per cent for each year is figured on the basis of the number exposed to risk. The figures representing those exposed to risk cover only those engaged continuously in flying and do not take into account flights of passengers who may be taken up but once.

A VIEW OF THE AVIATION SCHOOL AT SQUANTUM, MASS. ACTING GEN. LEROY SWEETZER FORMALLY HANDING THE SCHOOL OVER TO CAPT. WILLIAM R. RUSH, COMMANDANT OF THE FIRST NAVAL DISTRICT



THE CURTISS AEROPLANE COMPANY, BUFFALO, N. Y.
Member Aircraft Manufacturers' Association, Inc.
America Trans Oceanic Company, 280 Madison Ave., New York City, New York Agents



THE Curtiss Aeroplane Co. has always been the dominating center of aviation in America. Its capacity has steadily grown until today it is the largest and best equipped aeroplane manufacturing corporation in the world, amply equipped with all facilities for building a large variety of types of aeroplanes, hydroaeroplanes, flying boats and aeronautical motors in ***large quantities and for prompt delivery.***

THE CURTISPL
BUFF A.
Member Aircraft Associ
CABLE ADDRESS "CU ESTER

PLANE CO.

A.

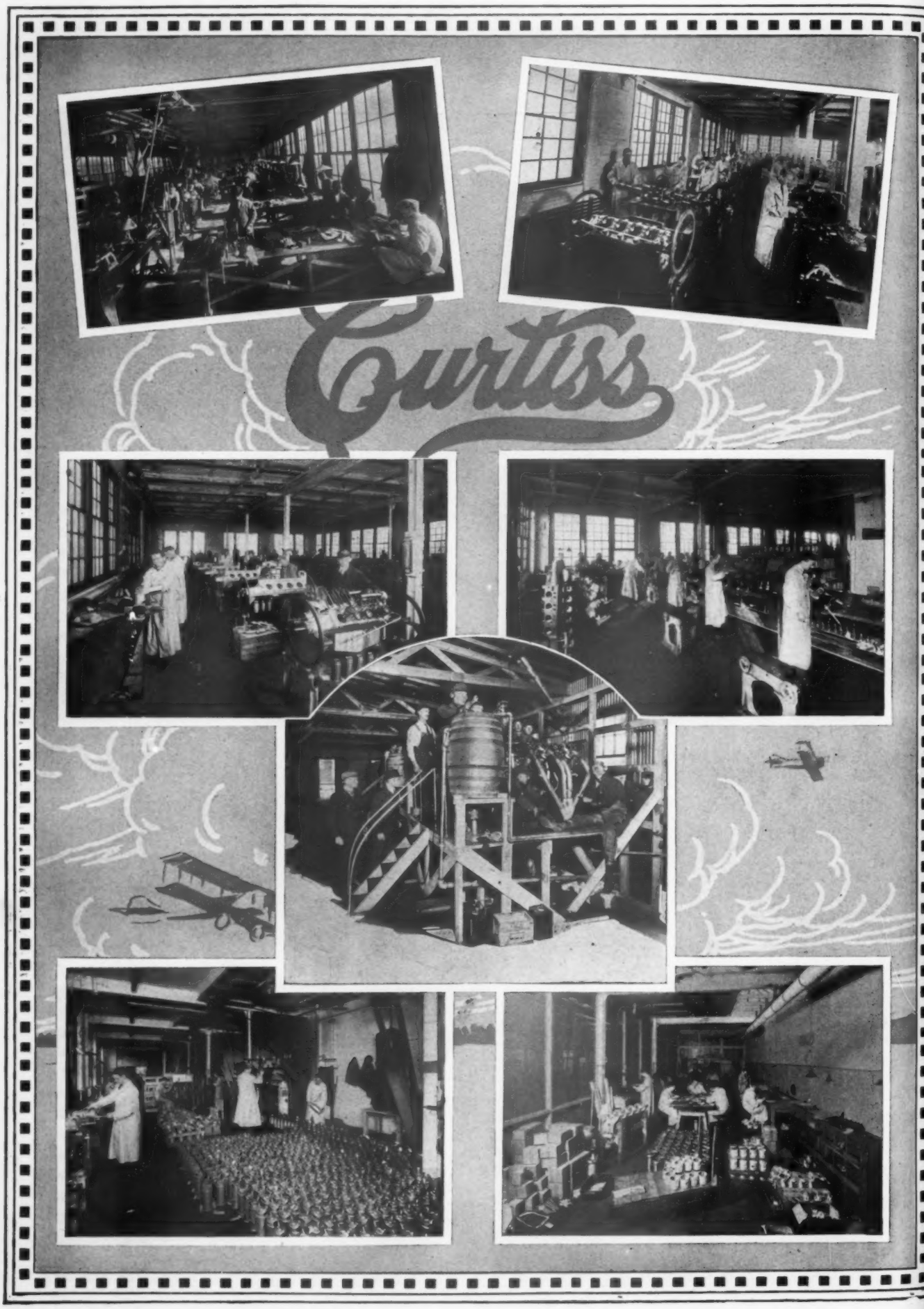
Association, Inc.

"CU ESTERN UNION CODE

In addition to the main plant and executive offices in Buffalo, N. Y., there are four other branch factories — three in Buffalo, N. Y., and one in Hammondsport, N. Y., as well as Training Schools, Hangars and Flying Fields at Buffalo, Hammondsport, N. Y., Newport News, Va., Miami, Fla., and San Diego, Cal.

The America Trans Oceanic Co., 280 Madison Avenue, New York City, New York Agents.

Curtiss



THE CURTISS AEROPLANE AND MOTOR CORPORATION, BUFFALO, N. Y.
Member Aircraft Manufacturers' Association, Inc.
America Trans Oceanic Company, 280 Madison Ave., New York City, New York Agents.

Chivalry of the Air

The *Echo de Paris* recently published a letter from an officer telling how he learned of the death of Capt, René Doumer, of the French Flying Corps.

The writer says: "A cavalryman came up to me and said he had a message for me. By the light of my pocket electric torch we went down together into my dugout, when he handed me a weighted message which had been dropped by an airplane, and which he had picked up in an open field on his way back from fatigue duty. It was a streamer of the German colors, black, white, and red, and attached to it was a gray linen packet weighted with a little sand. I opened the packet.

"It contained a white envelope with this inscription in large letters: 'To the Aviators of the —— Army.'

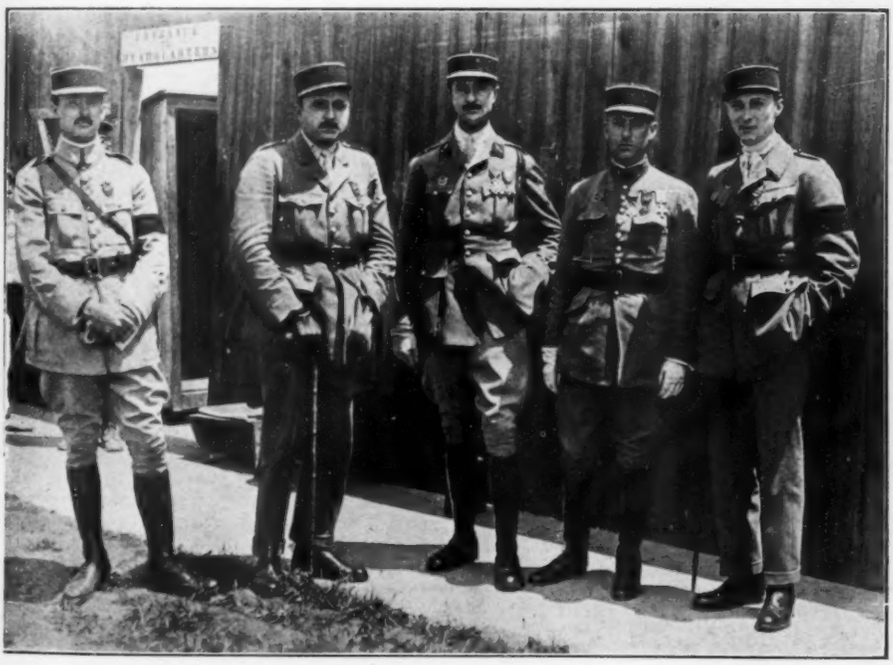
"Inside the envelope were two letters in German and two photographs. Here is a literal translation of the letters. The first runs:

"'Captain René Doumer, who fell in an air fight on April 26, 1917, north of Brimont, has been buried with German officers, and with military honors, in the military cemetery at Asfeld-la-Ville.'

"Two photographs of his grave are attached to the letter, one of them for Mme. Doumer. The second letter says:

"'On April 12, 1917, Lieutenant Louis Hemeret, Sergeant Robert Levy, and Corporal Jean Brunet fell heroically in air fighting near the forest of Orainville. They were buried with military honors.'"

It seems that the German aviators even respect their foes.



Photos Bain News Service.

FRENCH MILITARY AVIATORS NOW IN THIS COUNTRY. ABOVE, CAPT. DE BOYRIVEN; BELOW, LEFT TO RIGHT, SOUS LIEUTS. MONTARIOL, DE MAUDROT, MAIRESSE, DE DUCAS AND MARQUISAN.

Army Orders

First Lieut. Daniel P. Morse, Jr., S.O.R.C., to report for duty at New York, N. Y., in connection with the organization of the 1st Reserve Aero Squadron.

The following are detailed in Aviation Section of S.C. and rated as a junior military aviator from date after his name: Capt. John N. Reynolds, C.A.C., D.O.L., June 15; 1st Lieuts. Arnold N. Krogstad, 22d Inf., June 15; Harry M. Brown, 22d Inf., June 16; James R. Alfonte, Inf., D.O.L., June 17; Michael F. Davis, Inf., June 18; Patrick Frissell, 52d Inf., June 19; Adlai H. Gilkeson, Inf., June 20; Hubert R. Harmon, C.A.C., June 21; Jack W. Heard, 17th Cav., June 22, and Whitten J. East, Inf., June 23.

First Lieuts. Joseph H. Stevenson and Alexander B. Thaw, 2d, Aviation Section, S.O.R.C., to report at Governors Island for duty with 1st Aero Reserve Squadron.

First Lieut. John G. Colgan to Columbus, N. M., 1st Aero Squadron, S.C.

Capt. John W. Butts, S.C., report to commanding general, Eastern Department, for temporary duty as acting department aeronautical officer.

Capt. Byron Q. Jones, S.C., will report to Joint Army and Navy Aircraft Board, Washington, for temporary duty.

Capt. Herbert A. Dargue, S.C., relieved from detail in Aviation Section of S.C., June 9.

Major Robert Glendinning, S.O.R.C., to duty and report to Chief Signal Officer of Army for instructions.

First Lieut. Philip J. Roosevelt, S.O.R.C., to duty with Chief Signal Officer of Army.

Capt. Pierre DeL. Boal, S.O.R.C., to Fort Sam Houston, Texas, for duty.

Capt. Reginald L. Jones, S.O.R.C., to New York, N. Y., for assignment to duty.

First Lieut. Otto E. Strahlman, S.O.R.C., to active duty at Mineola, Long Island.

Par. 57, S.O. 117, War D., May 21, 1917, as directs 1st Lieut. Lawton V. Smith, S.O.R.C., to proceed to Fort Sam Houston, amended so as to direct him to proceed to Washington for duty.

Major Hiram Bingham, S.O.R.C., to duty with Chief S.O.

Appointments in the Aviation Section, Sig. O. R. C.

To be Captain, McCoy, James C., Miami, Fla. *To be 1st Lieut.*, Thomson, Clarke, Philadelphia, Pa.; Smith, Lawton V., Mineola, L. I., N. Y.; Roosevelt, Philip J., New York; Buckley, Daniel, Newport News, Va.; Noyes, Stephen Henley, Newport, R. I.

Requirements for Admission to Aviation Section, Officers' Reserve Corps

Owing to recent changes in the conditions under which applications for commissions in the Officers' Reserve Corps, Aviation Section, for flying duty are favorably considered, it is now possible for men without the formerly required three years' college course, or its equivalent, to be admitted. The minimum age limit has also been lowered.

The present requirements are briefly that candidates for examination to determine their fitness for receiving commissions in the Aviation Section, Officers' Reserve Corps, shall be between nineteen and thirty years of age, possess a college education or its equivalent and be able to pass a stringent physical examination covering eyes, ears, heart, lungs and sense of balance. Any near-sightedness, astigmatism or deafness is cause for disqualification.

In determining the equivalent of a college education, consideration will be given to the applicant's intelligence, business or other training, travel, tutoring, home study, activity and military training. In every case the applicant must have at least a high school or preparatory school diploma.

Detailed information with respect to the applicant's present occupation and past experience, knowledge of foreign languages, technical knowledge, athletic experience and ability, gas engine experience and theoretical knowledge and milieary training, should be given by all applicants who do not possess a degree from one of the recognized major colleges.

Examining boards give consideration to the above points.

Film Made of Standard Plant

The photographs used in the educational advertising of the Standard Aero Corporation were taken from the motion picture film made by the Universal Film Mfg. Company.

S. A. E. Summer Meeting

Probably the most successful meeting of the S. A. E. was held in Washington on June 24-25. On Monday, at the Bureau of Standards, the different standards Committee of the Society reported, accounts of which will appear in AVIATION AND AERONAUTICAL ENGINEERING when revised.

On Tuesday afternoon papers were read by Henry R. Sutphen, vice president of the Elco Company and Submarine Boat Corporation on "Building Submarine Chasers by Standardized Methods"; H. L. Horning, general manager, Wakesha Motor Company, on "The Farm Tractor as Related to the Food Problem"; Wing Commander I. W. Seddon of the Royal Naval (English) Air Service on "Design and Production of Aircraft in War Time"; C. E. Sargent, chief engineer of the Lyons-Atlas Company on "Fundamentals of a Successful Kerosene-Burning Tractor Engine"; W. O. Thomas on "Lessons of the War in Truck Design"; and a paper by Lieut. De la Grange of the French Commission, which appears elsewhere in this issue.

Tuesday evening a dinner was given at the New Willard hotel, which seven hundred members and guests attended. President George W. Dunham presided and Judge Benton Crisp acted as toastmaster. Other speakers were Hon. Newton D. Baker, Secretary of War, E. A. Deeds of the Aircraft Production Board, Wing Commander I. W. Seddon and Lieut. De la Grange. At the guest table were: Brig.-Gen. Geo. O. Squier, Lieut. De La Grange, Capt. J. S. Critchley, Coker F. Clarkson, J. G. Vincent, Admiral Taylor, Admiral Griffin, C. M. Manly, H. M. Swetland, Brig.-Gen. Kuehn, H. L. Horning, S. D. Waldon, Col. John R. Rice, Col. H. C. Fisher, J. G. Utz, W. F. Gifford, Col. Scott, Dr. S. W. Stratton, David Beecroft, Major Moody, Major Drake, Al Reeves, Henry Souther, Daniel Willard, C. W. Stiger, K. W. Zimmerschied, Dr. Dickinson, Henry R. Sutphen, Dr. H. M. Rose, F. E. Moskovics, B. B. Bachman, L. M. Bradley, Grosvenor B. Clarkson, Herbert Chase, and C. W. McKinley.

U. S. Aircraft Experts Arrive at a British Port

The Council of National Defense authorizes the following:

The Aircraft Production Board announces the safe arrival at a British port of a group of nearly 125 experts, sent from this country to acquire and bring back to the United States all possible information regarding aircraft designing and manufacture of both engines and planes. Included in the delegation are men representing legal, manufacturing, designing, engineering, military, and naval experience and training.

Canadian Division of the Aerial League of the British Empire

The Canadian Division of the Aerial League of the British Empire has arranged for AVIATION AND AERONAUTICAL ENGINEERING to be forwarded to every member of the Division during the coming year.

The officers of the Canadian Division are: Patron, His Excellency the Governor General; honorary presidents, Rt. Hon. Sir Robert L. Borden, C. C. M. G., P. C., Baron Shaughnessy and Rt. Hon. Sir Wilfrid Laurier, G. C. M. G., P. C.; president, Sir H. S. Holt; vice-presidents, Hon. Sir Charles Davidson, Hon. Senator J. P. B. Casgrain, Major General E. W. Wilson, W. A. Black, Esq.; chairman, George E. Drummond, Esq.; honorary treasurer, A. K. Fisk, Esq., C. A.; honorary assistant treasurer, E. Greenwood, Esq.; honorary secretary, George R. Lightall, Esq.; honorary legal advisor, W. D. Lightall, Esq., K. C.; executive committee, Brig. Gen. A. E. Labelle and Messrs. F. L. Wanklyn, A. D. Mactier, Huntley R. Drummond, Charles Fergie, J. H. Sherrard, J. H. Magor, William McMaster, James S. Brierley, George G. Foster, K. C., Guy Tombs, J. J. McGill, Lansing Lewis, William M. Birks, James Davidson, Thomas E. Hodgson and James Cleghorn.

The Lawson Aircraft Company

Alfred W. Lawson, who is well known in American aeronautics, has organized the Lawson Aircraft Company, with offices and plant at Green Bay, Wis., and plans are now going forward for the manufacture of airplanes on a large scale.

Mr. Lawson is vice president and general manager of the company and among his associates are such well known and experienced aircraft men as L. M. Allison, chief engineer; Lee Wallace, aeronautical designer; John Carisi, factory superintendent; and as foremen of the different departments Rudy Sanders, Andrew Surini, Harry Graulick, and Frank Schober.

The first Lawson machine, a military tractor biplane, which will be equipped with Hall-Scott A-7-a engine, is nearing completion, and will be ready to undergo flying test some time this month.

Aerial Mail Service in Italy

The American Consul at Turin, Italy, sends the following report to the State Department:

The firm of Pomilio & Co., of Turin, intends within a few days to inaugurate an air transport service between this city and Rome. Permission has been accorded by the Italian minister of posts and telegraphs for the carrying of mail between the two cities and the surrounding sections, and until special stamps have been issued by the Government the ordinary "express" or "special delivery" stamp of $0.05 is to be used, with a note made on the envelope that the letter is to be sent by airplane. No stamp other than the "special delivery" is required, but the using of this stamp for this particular service does not imply the delivery of the letter by special messenger to destination, as would ordinarily be the case. Special letter boxes are to be placed in the post offices and railway stations in both Rome and Turin wherein letters for the air post may be deposited.

Age Limit for Aviators

The interesting fact that under the provisions of the National Defense Act there is no fixed minimum age for applicants to enter the Officers' Reserve Corps is brought out in a recent opinion of the Judge Advocate General. The opinion was rendered upon a request from the Chief Signal Officer that authority be sought to reduce the "minimum age limit of applicants for commission in the Aviation Section, S. O. R. C., from twenty-one to nineteen years." The Chief of Staff concurring in this recommendation, the legal department was instructed to draft the proposed legislation. It was then discovered that no amendment or new enactment would be necessary. "The National Defense Act prescribes only a maximum limit for the various grades of the O. R. C.," said General Crowder, Judge Advocate General.

Permanent Aircraft Exhibit

A permanent exhibit of aircraft materials, including engine parts and sections of planes, will soon be opened at Washington by the National Advisory Committee for Aeronautics and the Aircraft Production Board for the benefit of army and navy engineers and American manufacturers.

The latest foreign machines, reflecting the development of European building science after three years of the war, will be displayed to enable engineers to study new adaptations for use in the creation of America's new air fleet.

Announcement

Aviation and Aeronautical Engineering

Beginning July 1, 1917

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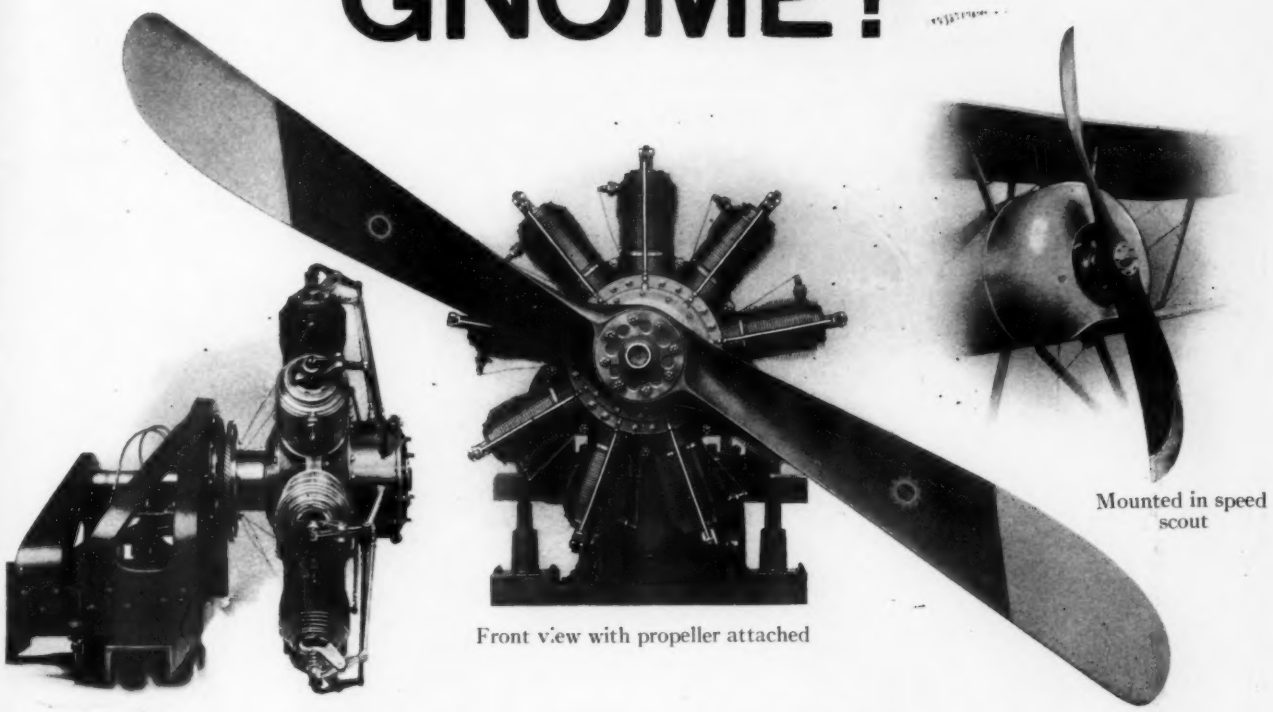

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Front view with propeller attached

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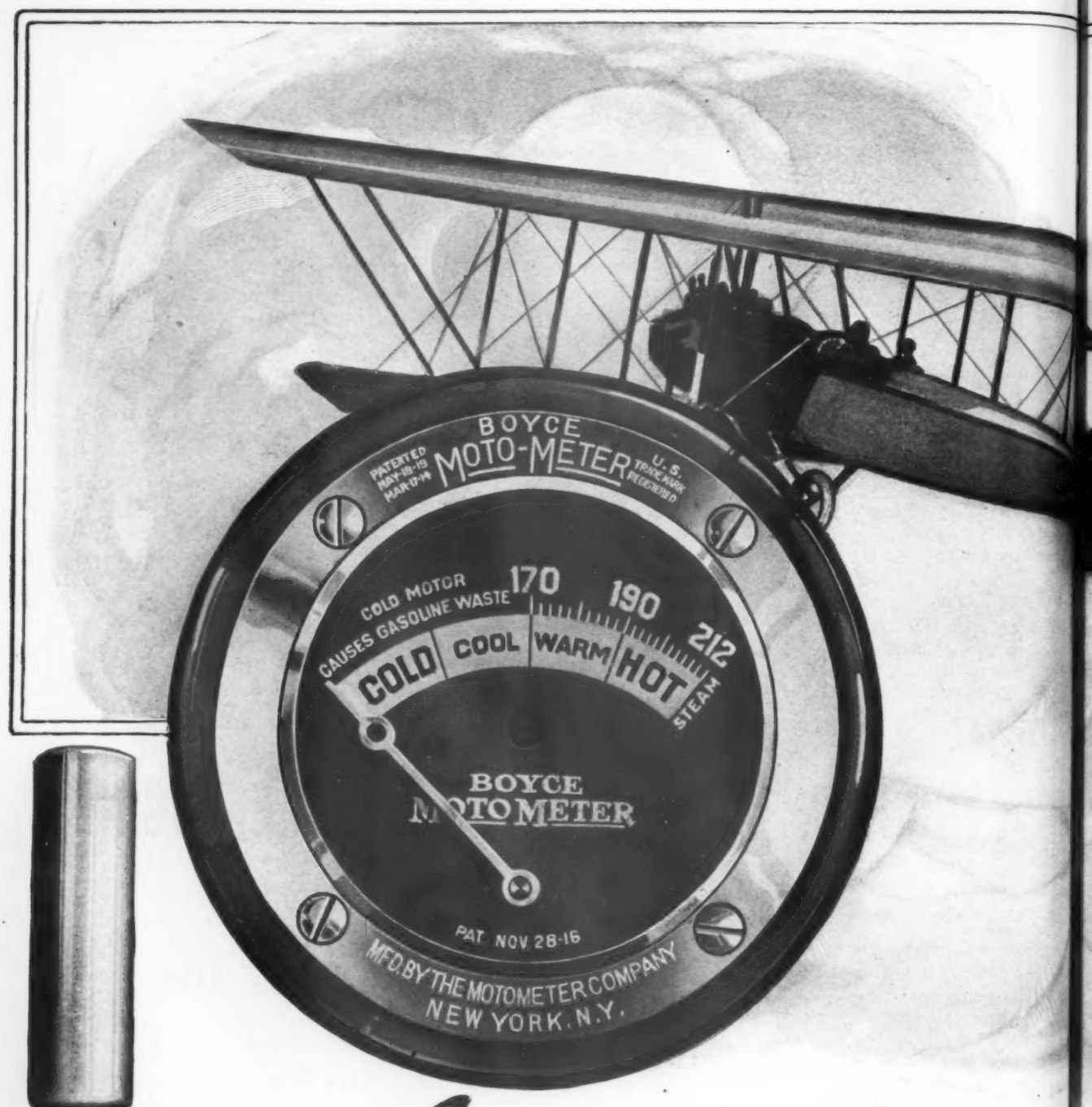

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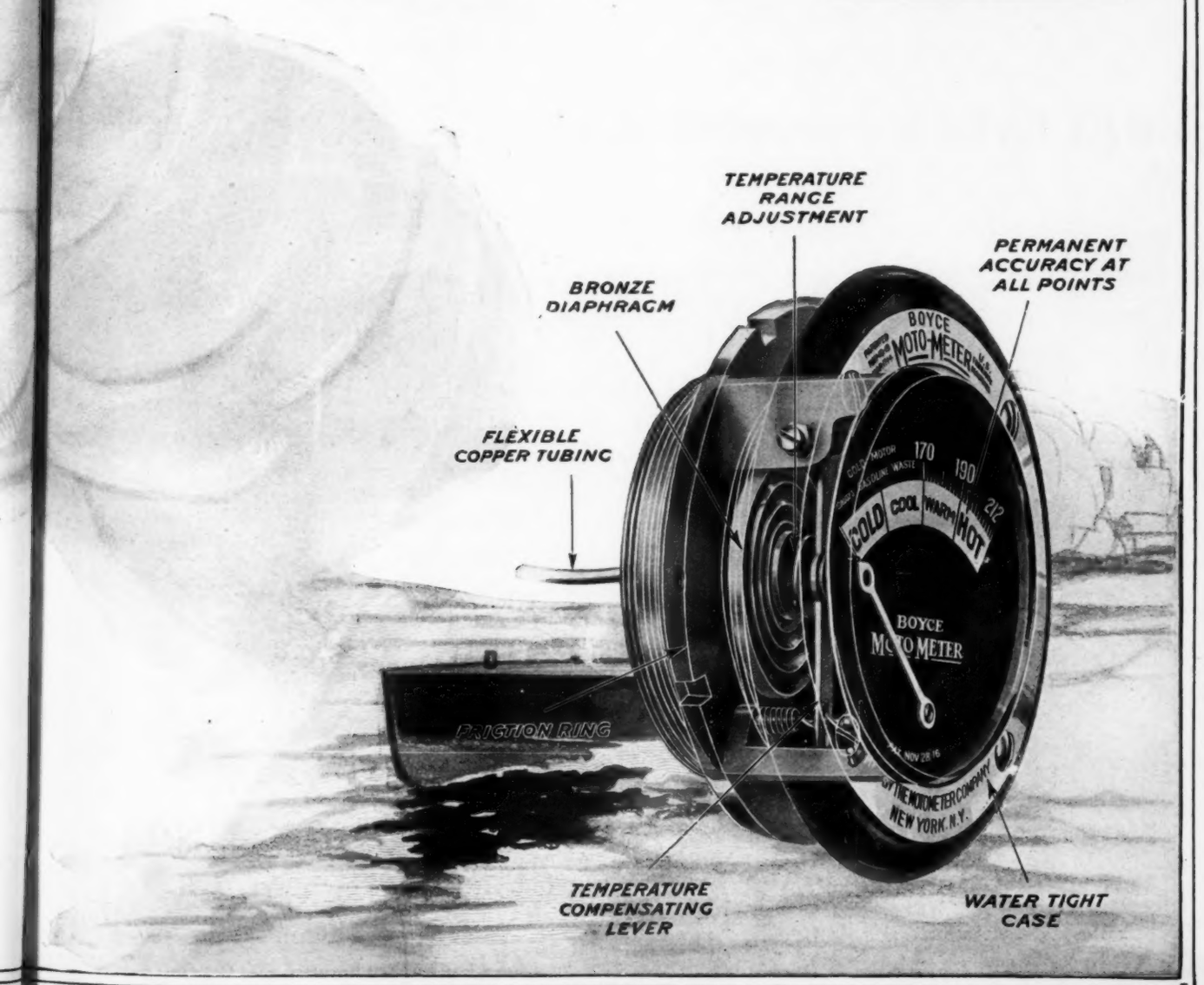

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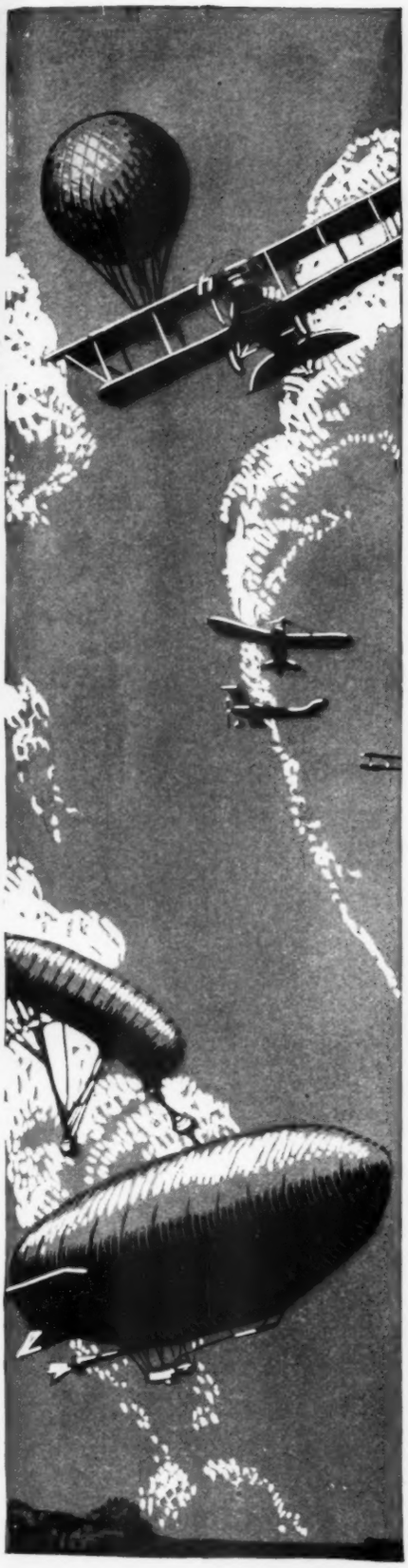

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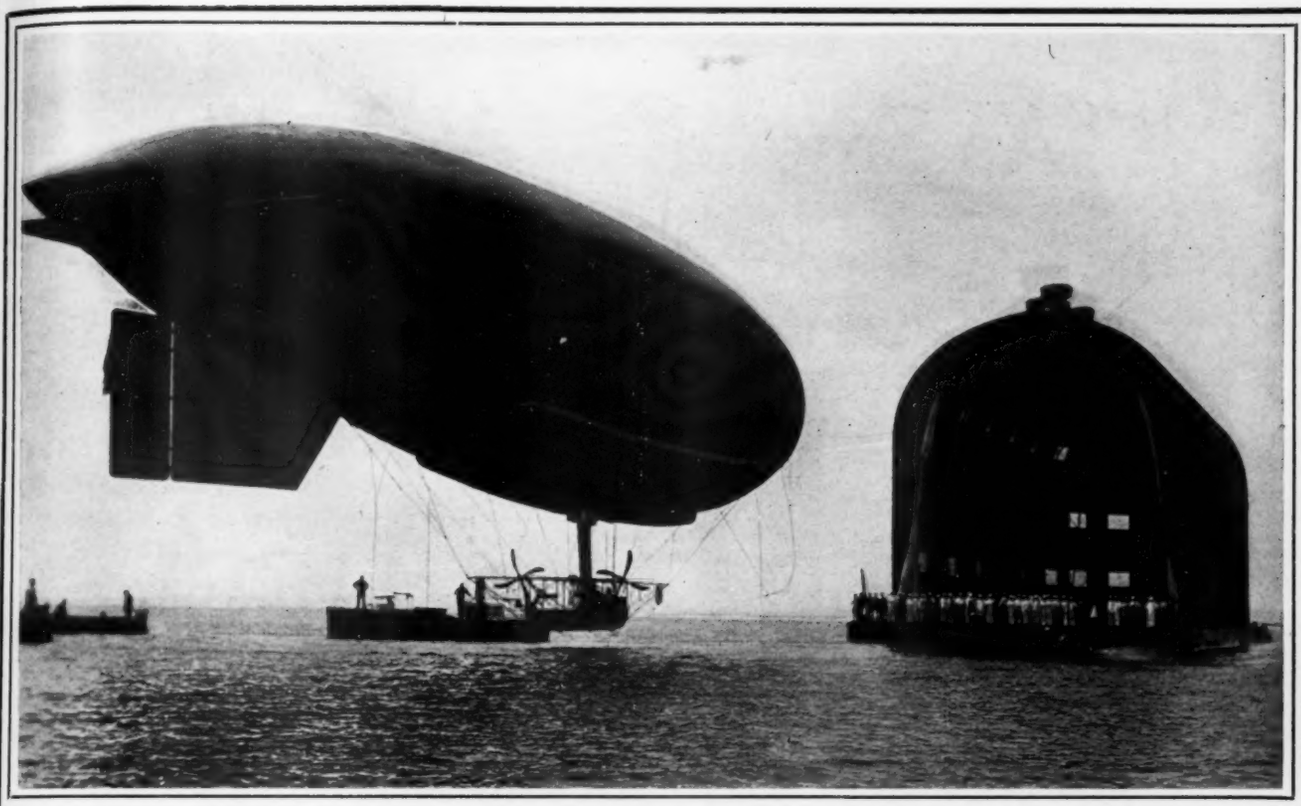

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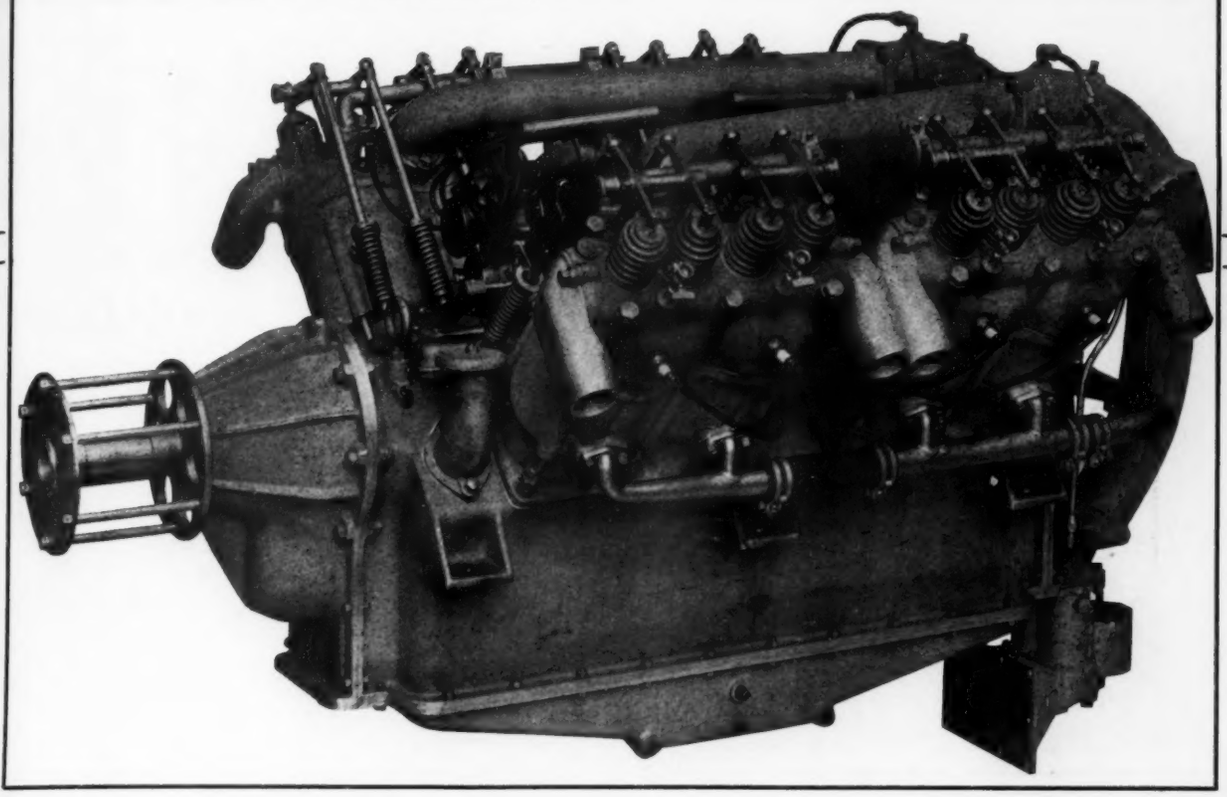

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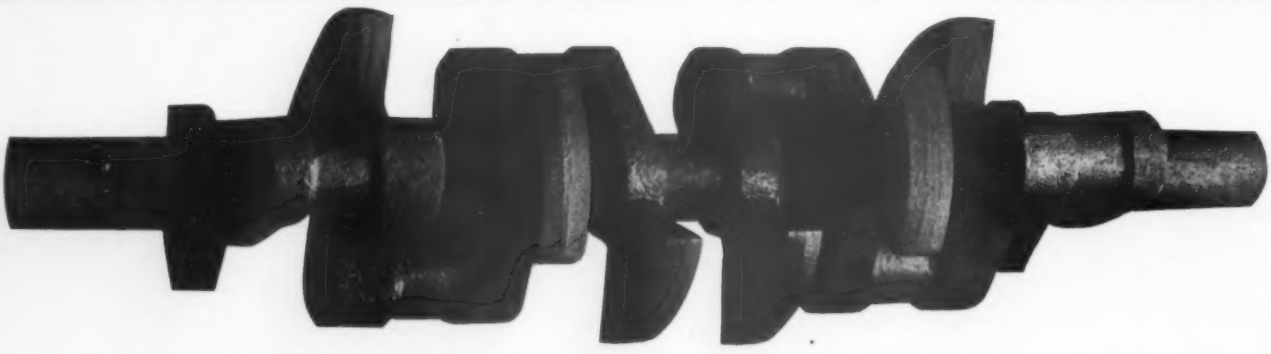

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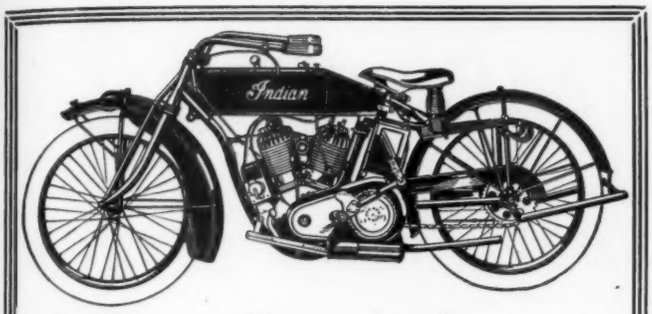

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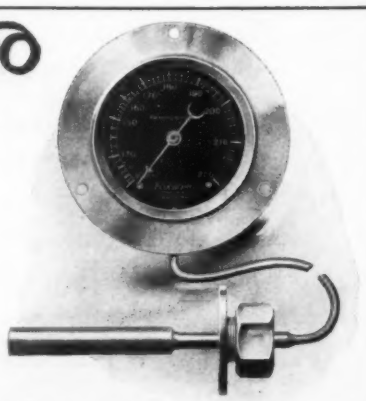

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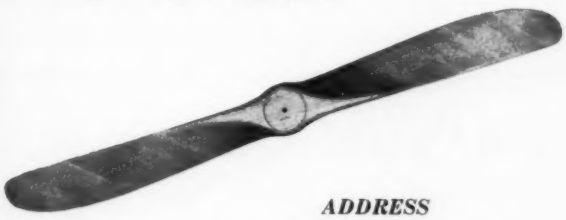

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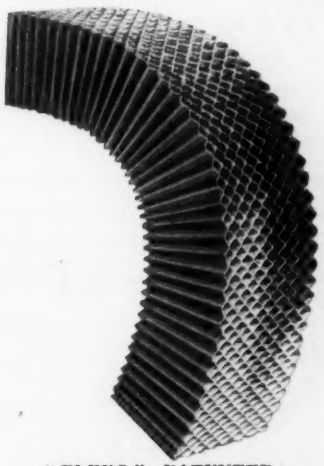

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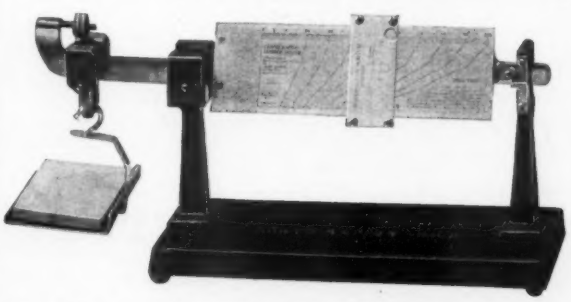

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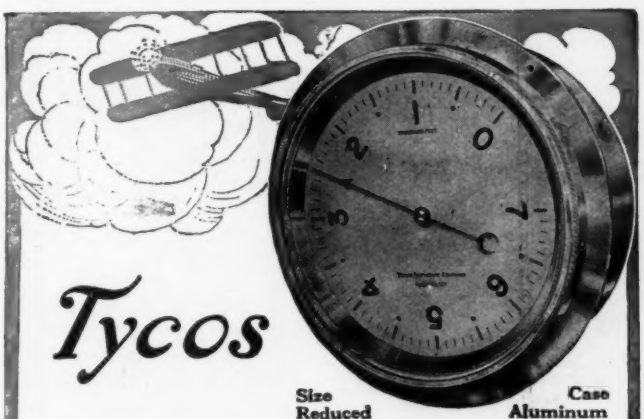

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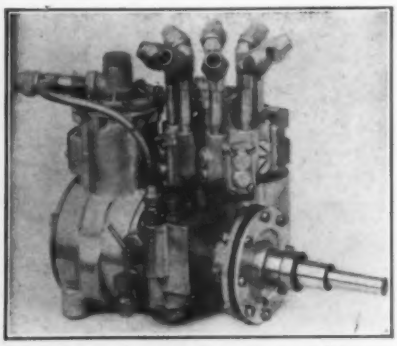

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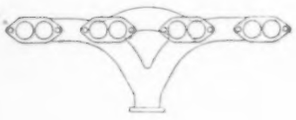

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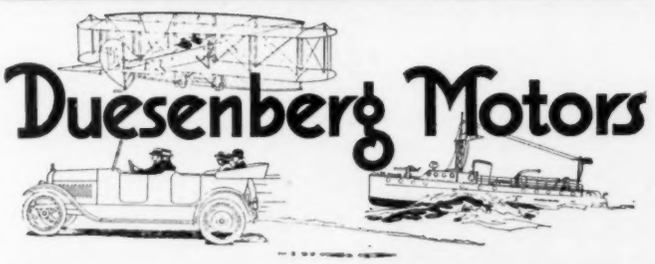

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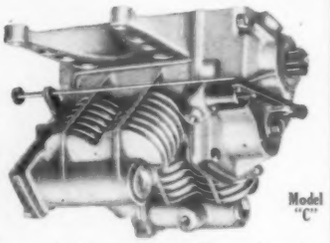

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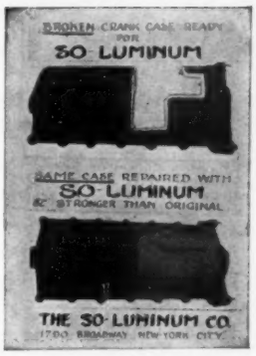

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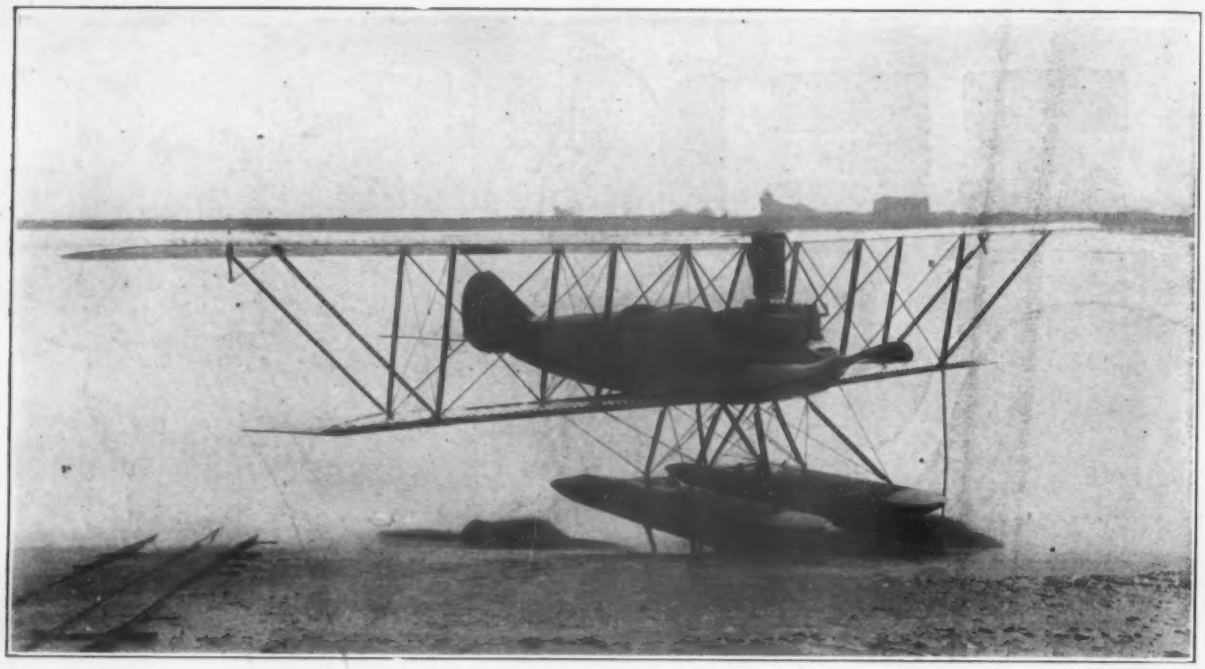

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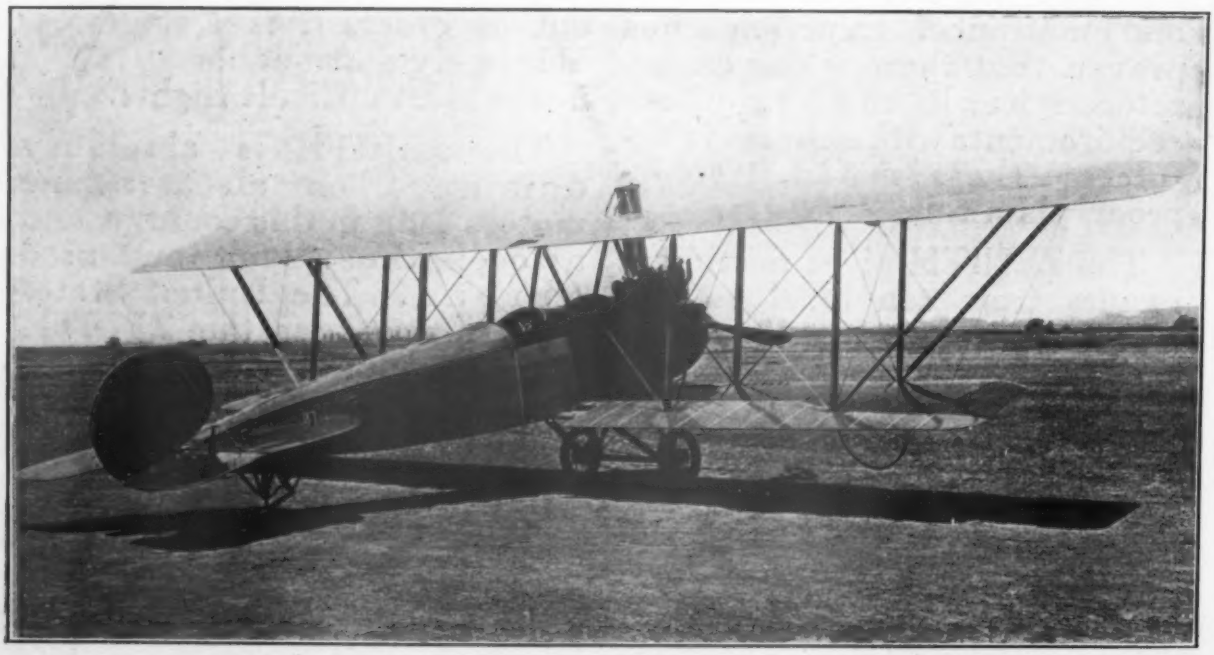
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